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OUTLINES

OF

PHYSIOLOGY, ANATOMY, AND SURGERY.

BY

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BIBLIOTHECA · BOD

EDINBURGH:
MACLACHLAN & STEWART.
LONDON: SIMPKIN, MARSHALL & COMPANY.
DUBLIN: HODGES & SMITH.

MDCCCLI.

165. c. 27.

PRINTED AT THE UNIVERSITY PRESS,
32 THISTLE STREET, EDINBURGH.

PREFACE.

The object of the Author in preparing the following sheets, has been merely to present those prosecuting the study, or engaged in the practice of medicine, with as clear and full an exposition of some of the principal facts and doctrines of the sciences treated of as the limits to which he confined himself would permit. The work will not be found to possess anything remarkable for novelty either in plan or execution, much less was it intended to supersede any of the many excellent works upon the individual subjects already extant. Indeed, the space to which the Author limited himself, rendered it impossible for him to produce anything worthy of a higher title than that of "Outlines."

Instead of the strictly methodical arrangement that would have been necessary in a more elaborate work, he has allowed himself a certain freedom from such trammels; and thus, for example, by relieving anatomical descriptions with surgical or pathological remarks, and by assuming a somewhat familiar style of language, the author hopes to have rendered his work a useful one, and as pleasant to read as the nature of the subjects would allow. The object has been to prepare a book which, while it would be found useful to gentlemen prosecuting the study of medicine, might not prove unacceptable to practitioners, containing as it does simple statements regarding facts and theories, as understood or promulgated by the highest authorities in the different sciences

W. W.

Edinburgh, *May* 1851.

PART I.—PHYSIOLOGY.

THE human body consists of numerous exquisitely formed organs, permeated in every direction by a stream of living blood, from which alone they derive their nourishment and life. While the blood continues to flow, the body continues to live; but with the final stoppage of this vital stream, life becomes extinct. Stoppage of the circulation, therefore, is practically equivalent to the extinction of life: and although the nature of life is totally unknown, yet its existence in all living beings is intimately associated with the constant transmission of a nutritive fluid throughout their substance. In mineral bodies, and in animals deprived of life, no motion whatever can be detected; and thus the human mind invests the idea of death with the essential characteristic of perfect stillness.

As the organs of the body are continually undergoing a process of disintegration, so their melted elements are continually entering and mingling with the living stream; and it cannot be too carefully remembered that the blood is the only medium through which the permanent organs can free themselves of their constantly decaying tissue. In the blood remarkable changes are constantly in progress, by which poisons are prepared for elimination at the glands, and the fresh food newly absorbed receives the mysterious endowment of life.

CHEMICAL COMPOSITION OF THE HUMAN BODY.

Carbon, hydrogen, oxygen, and nitrogen, with sulphur and phosphorus, constitute the essential elements of all living tissues. But as alkaline and earthy salts are always present both in the solids and fluids of the body, they are probably quite as essential to the perfection of the soft parts as they certainly are to such structures as teeth and bones.

The elements are combined by vital power into albuminous, gelatinous, and fatty principles; but the pigmentary, mineral, and extractive matters are most probably the result of chemical agency alone.

I. THE ALBUMINOUS, or PROTEINE COMPOUNDS are albumen, fibrine, and caseine. These, as they naturally exist, dissolved in the animal fluids, are perfectly characterized by their mode of coagulation. Fibrine coagulates spontaneously, albumen by the influence of heat, caseine by the action of rennet or acetic acid. Their exact composition is not known, but the general belief is that albumen and fibrine consist of proteine (C^{48} H^{36} N^{6} O^{14}) in union with sulphur and phosphorus in the free state, and that caseine has the same composition, except that it contains no free phosphorus. They all contain phosphate of lime, which is found in their ashes. It is only in the healthy animal fluids, which are always faintly alkaline, that the characteristic peculiarities of the proteine compounds can be recognised; for if albuminous solutions are rendered decidedly acid or decidedly alkaline, either by natural, morbid, or artificial means, their properties are lost. This is well exemplified by the process of digestion, in which the albuminous principles lose entirely their distinctive qualities.

ALBUMEN exists in an organizable and organized form in almost every tissue of the body, and also as a fluid in the serum of blood, &c. Coagulation begins in the serum at 150° to 170°, but weak solutions require a boiling heat, and merely become flaky or opalescent. Acetic acid, bibasic, and tribasic phosphoric acids, do not precipitate albumen. But tannic acid, alcohol, and creosote, as well as the mineral acids and most metallic salts, possess this power. Corrosive sublimate will detect 1·2000th part of albumen in solution.

Albumen is not only the solvent and vehicle for the earthy salts, but also the universal organizable material which, in union with oil, may be converted into every living tissue.

FIBRINE exists as a solid in muscular fibre, and as a fluid in the liquor sanguinis. During coagulation it forms a delicate network, which is well seen in blood clot; and fibrine may be obtained by whipping coagulating blood with a bundle of twigs. Fibrine contains about 2 per cent. phosphates of lime and magnesia.

CASEINE exists chiefly in milk, but has been detected in the blood and pancreatic fluid. It is coagulated from its solution as well by the reagents that do as by the acids that do not coagulate albumen. It contains 6 per cent. of phosphate of lime and a little potash.

The Proteine compounds are distinguished from other azotised compounds by forming a purple solution when digested in warm hydrochloric acid.

II. THE GELATINOUS COMPOUNDS are gelatine and chondrine. The former is obtained by boiling bones, membranes, and white fibrous tissues in water. A warm solution containing 1·100th part of gelatine forms a jelly on cooling; but very weak solutions do not gelatinize. It is precipitated by alcohol, creosote, and corrosive sublimate, but tannic acid detects even 1·5000th part in solution. Chondrine does not form so strong a jelly, but is precipitated by the same reagents as gelatine, and also by acetic acid, alum, and persalts of iron, which do not throw down gelatine.

The composition of gelatine is C^{48} H^{41} $N^{7\frac{1}{2}}$ O^{18}; that of chondrine C^{48} H^{40} N^{6} O^{20}; but these are doubtful. They both contain sulphur. Gelatine is an excellent solvent of phosphate of lime, and naturally contains it.

III. THE FATTY PRINCIPLES. Oleine, margarine, and stearine, are the *saponifiable* fats. The first is liquid; the other two are solid, and crystallize at 60°. They consist of oleic, margaric, and stearic acids in union with glycerine. Fat cells contain oleine and margarine in a fluid form; but when the cells are removed from the body, they present a radiated nucleus of crystallized margarine. The fats in the blood are saponified by soda or potash. The brain contains two peculiar fatty acids: the oleophosphoric, which is liquid, and contains phosphorus, and the cerebric, which is solid, and contains both nitrogen and phosphorus.

The *unsaponifiable* fats are cholesterine and serolin: the former exists chiefly in the bile; the latter in the blood.

All fats are dissolved by ether.

IV. THE PIGMENTARY MATTERS. The hœmatine of blood, which contains 7 per cent. of iron, the brown pigment of muscle and of nerve cells, the yellow and green pigments of bile, and finally the black pigment of the choroid and other parts, all belong to this class of compounds. The formation of pigments, especially the black variety, is little known.

V. THE MINERAL MATTERS are phosphates of lime and magnesia, with carbonate of lime forming the bones and teeth; and to these indeed may be added all the other inorganic salts in the body.

VI. THE EXTRACTIVE MATTERS. After chemical analysis has done its best to separate the proximate principles, there still remain the *extractive* *matters*, which are all soluble in water. Osmazome and zomidine, which are supposed to be the source of odour in cooked meat, and the extractive matter of blood, are excellent examples They are always associated with lactates and other salts.

STRUCTURAL COMPOSITION.

The liquor sanguinis, by which the textures are continually regenerated, is without doubt very similar in composition to the transparent fluid contained in the embryo cell from which the living being was originally developed. These fluids indeed, which are saline solutions of albumen and oil, may be looked upon as the type of all organizable fluids intended for the nourishment of animal beings.

The tissues are developed from cells according to Schwann, from nuclei according to Henlé, and from molecular matter according to J. H. Bennett. But as cells, and nuclei, and molecules, all originate from a perfectly structureless fluid, this apparent difference of opinion has reference merely to the form assumed by the solidifying blastema, preparatory to its being remodelled into the elementary tissues: and although granules, nuclei, and cells, differ remarkably in relative size, yet they do not invariably differ in more important respects; for a granule may expand into a nucleus, and a nucleus may become a cell. But in development there is this marked distinction, that granules form tissue by their *aggregation* alone, whilst nuclei and cells do so by undergoing remarkable changes in form.

1*st*, In liquor sanguinis, during coagulation, minute granules arrange themselves in rows, melt together, and solidify into fibres.

2*d*, In morbid growths, nuclei elongate and throw out branches that split up the coagulated blastema into dense fibrous tissue.

3*d*, In inflammatory exudations on serous membranes, fibres are also produced by the elongation and splitting up of fibro-plastic cells.

4*th*, The sarcolemma of muscular fibre, and the neurilemma of nervous fibre, are formed by the union of cells in a linear series, and by the melting down of their contiguous walls.

5*th*, The branches of radiating cells anastomose, and form the capillary tubes.

6*th*, Membranes certainly are formed by the coalescence of cells; but it is very probable that they may also be formed by the aggregation and melting together of granules.

From these statements this great principle may be established, namely, that tubes alone require for their development the previous existence of cells.

There are six elementary forms of Tissue existing in the body—

I. MOLECULAR and GRANULAR MATTER consists of particles that vary in size from immeasureable minuteness to 1·10,000th of an inch in diameter; and these particles are called molecules or granules, according to the appearance they present when examined with a magnifying power of 300 diameters, which is the best adapted for the examination of animal structures.

Granules vary greatly in size, but always exhibit a dark margin with an abrupt external edge, and, when transparent, either a clear or a dark centre, according as the edge or the surface comes into view.

Molecules are merely indistinct granules; but under a higher magnifying power molecules become granules, and new molecules appear.

Granules consist of oil, or albumen, or pigment, or mineral matter; but most frequently of oily particles coated with albumen.

Ether dissolves the oily, acetic acid the albuminous, nitric or hydrochloric acid the mineral granules.

The molecules and granules in salivary globules and in organic fluids have peculiar vibratory movements, which are called *Molecular*.

II. NUCLEI are either *free* or *contained* in cells, or *imbedded* in tissues. They are sometimes vesicular and clear, but often granular. Acetic acid either does not affect them or renders their edges darker. Some corpuscles that are called Nuclei by one physiologist are considered as cells by another, according to the view each one adopts in regard to their mode of origin. But the term nucleus has really no distinctive meaning, unless it be used to characterize a corpuscle that either does exist, has existed, or may yet exist, within the cavity of a cell.

III. CELLS. What are cells, then? They are vesicles containing either a clear or a granular fluid, and generally, also, a more conspicuous body, called a nucleus, which does not usually partake in the changes of form that its containing vesicle undergoes. If the cell wall is not transparent, acetic acid very often renders it so, and then the nucleus appears if the cell contains any.

There are eight distinct kinds of cells existing in the human body :—

1. *Blood Cells* that animate and invigorate the liquor sanguinis, and make it fit to nourish the tissues. These are the yellow and the white corpuscles. *a.* The yellow corpuscles are circular, flattened, biconcave discs, with rounded edges, but no nucleus. Their average diameter is 1·3500th of an inch, and their thickness ⅓ or ¼ of this. They have a very pale saffron-yellow colour, and are quite transparent ; but when accumulated in mass, they produce the crimson colour and opacity of blood. They are composed of a delicate, homogeneous, and highly elastic membrane, containing a fluid in which the colouring matter is dissolved ; although some think that the hœmatine merely lines the inner surface of the membrane. They are considered by some to be the nuclei of the white corpuscles. By the addition of water they swell by endosmosis and become globular ; and when syrup is added, they shrink by exosmosis ; but in a fluid having the sp. gr. of serum (1028), they retain their discoid form. When exposed for some time they change form, becoming crenated or beaded at the edge, sometimes elongating or assuming a horse-shoe shape. Acetic acid

dissolves the outer part of the corpuscles, so diminishes their size. The corpuscles of fœtus are larger than those of the adult, and present nuclei.

In mammalia the yellow corpuscles are smalle than in any other class; being largest in the elephant and smallest in the musk-deer. Their form is always circular, and they are not nucleated except in the camel tribe, whose corpuscles are both oval and nucleated.

In birds, reptiles, and fishes, they are *oval* and *nucleated*, except in the Cyclostomatous (Round-mouthed) fishes, such as the lamprey and myxine, in which they are circular and biconcave as in man.

The corpuscles of birds are smaller than those of mammals; next in order are those of fishes; largest of all are those of the true Amphibia among reptiles: in the proteus and siren they are 1·400th of an inch in long diameter, and in the frog 1·1000th. The Invertebrata have colourless corpuscles, but they are discoid.

b. The white or colourless corpuscles are globular and nucleated, and present a granular surface which is removed by acetic acid, and a nucleus becomes developed. Their diameter is about

1·2500th of an inch, and their structure varies according to the state of development they have attained. In health their proportion to the yellow discs is about 1 to 50 ; but in young animals, and in adult blood during inflammation, they are greatly more numerous. Their number is also much greater in disease of the spleen. They are the same as lymph or chyle corpuscles, and by some are supposed to develope the yellow corpuscles within their cavity. In addition to these kinds of corpuscles, there is also a large number of minute granules floating about in the liquor sanguinis; and this matter is of course greatly increased in diseases that cause degeneration of the yellow discs.

2. *Gland Cells* are in reality a variety of Epithelium, but differing from the ordinary in being free. They eliminate the secretions from the blood, and subsequently their cell-walls melt and form part of the secretion. It is proper to remember that no distinction in structure can be observed between those that secrete bile, and those that elaborate urine or saliva.

3. *Fat Cells* are chiefly to be looked upon as the reservoirs of combustible matter, from which the body may derive a supply of animal heat whenever necessity may require; but when the

oil is not used for this purpose, these cells afford a protection against cold; while, by filling up the angular intervals between muscles, &c. they give rotundity and beauty to the form. They are round or oval, and may be slightly altered in form by pressure. Their diameter is 1·200th to 1·600th of an inch, and sometimes smaller. They consist of a very delicate membrane enclosing oil, which consists of margarine and oleine; and when fully developed they are not nucleated. A radiated crystallization of the margarine they contain may be usually observed in one part, which is probably the seat of the nucleus. Acetic acid, if strong, dissolves the membrane entirely, and then the oil escapes. Fat is never found in the subcutaneous cellular tissue of the eyelids, scrotum, and penis; nor in the lungs and cranial cavity.

4. *Pigment Cells* are for the absorption of light, that might injure the perfection of the image formed on the retina; and this is their most obvious use in the choroid coat of the eye. But in the iris they modify the rays of light, and have a beautiful effect in colouring this structure: elsewhere their use is not so obvious. The cells are either spheroidal or else six-sided by mutual pressure.

5. *Nerve Cells* are generally spheroidal in shape, and vary in diameter from that of a blood disc to 1·300th of an inch. There are three principal sizes of these cells. The smallest resemble the nuclei of the middle sized; they are transparent, and contain a minute clear granule. The middle sized, again, are very like the nuclei of the largest, are also transparent, and contain one or more nuclei. The largest cells contain a brown granular matter, in which one or more large vesicular nuclei may be imbedded. Acetic acid, which dissolves the granular matter, of course renders the nucleus more distinct. It is to this kind of nerve cell that the name of Ganglionic Corpuscle has been more particularly applied. They are often elongated, angular, or branched, and from this last characteristic some have been called Caudate Cells.

Nerve cells are the only source of nervous power. By them alone impressions are felt and irritations reflected: they are in fact the rulers of the nervous system.

6. *Epithelium Cells* cover and protect basement membranes, and elaborate the secretions in the recesses of the glands.

a. Tesselated or Scaly Epithelium consists of delicate flattened cells of an hexagonal form. A single layer is found on the inner surface of the heart, bloodvessels, and absorbents; of the air-cells of the lungs, the serous and synovial membranes. The capillary vessels are not lined by Epithelium.

The laminar or stratified variety consists of many layers of cells which are scaly at the surface, spherical near the basement membrane, and of intermediate form between these. It constitutes the scarf skin with the hair and nails; covers all the parts with which the food comes in contact from the mouth to the cardiac orifice of the stomach; lines the vagina and vulva, and extends a short way into the canal of the cervix uteri; covers the ocular conjunctiva, and lines the lachrymal ducts; and finally it exists at all the mucous outlets.

b. Columnar Epithelium consists of cylindrical or conical cells that are always distinctly nucleated. It covers the alimentary mucous membrane from the cardiac orifice of the stomach to the internal sphincter ani; it lines the gall-bladder and all the gland ducts that open on the mucous surface, except at their commencement; it also lines the urethra, except at its orifice. The spheroidal is a transition form between the scaly and cylindrical, and differs from the glandular only in function. It is almost confined to the urinary mucous membrane. It lines the bladder, ureters, and pelvis of the kidney, as also the ducts of the mammary and sweat glands.

c. Ciliated Epithelium does not differ from the preceding varieties, except in the existence of delicate hair-like processes that are attached around the margin of the cells, and move with a lashing motion during life, and for some time after death.

Ciliated cylindrical epithelium is observed on mucous membranes only. Commencing a little within the nostrils, it lines the meatuses of the nose and the cavities that communicate with it; namely, the maxillary antra, the sphenoidal and frontal sinuses, and the ethmoid cells. It then lines the nasal duct and lachrymal sac, is interrupted by the scaly epithelium of the lachrymal ducts, but reappears upon the palpebral conjunctiva. Extending backwards, it covers the nasal region of the pharynx, and passing along the eustachian tube, it lines the tympanum; commencing again a little above the glottis, it then lines all the air tubes as far as the air cells, into which, however, it does not enter. On all these parts, its obvious use is to move on the mucous secretion under circumstances in which muscular contraction could not assist.

The uterus and fallopian tubes with their fimbriæ are lined with this variety of epithelium; and in the tubes the motion of the cilia is, as usual, towards the mucous outlet, and may serve to facilitate the transit of the ovum.

Ciliated tesselated epithelium exists in the lateral ventricles of the brain; its purpose is unknown.

The animal fluids, serum, milk, urine, &c., promote ciliary motion, but bile immediately stops it.

7. *Cartilage Cells* generally have an irregular form, an indistinct outline, and a clustered arrangement. In permanent cartilage, the matrix is clear or granular; in spongy cartilage, such as the epiglottis, it is almost entirely changed into yellow elastic tissue; and in fibro-cartilage the matrix is often quite transformed into white fibrous tissue.

There is nothing peculiar about cartilage cells during their early life; and after they have been altered by age, their distinction into nucleus and cell-wall is by no means easy.

8. The human *Ovum* has a globular form, and varies in diameter from 1·240th to 1·120th of an inch.

It consists of a clear and distinct vitelline membrane, containing the granular yelk, in which is imbedded the delicate germinal vesicle. The granular nucleus of this vesicle is called the germinal spot.

Now, although differences do exist among cells in the advanced stage of their existence, all of them present the same appearance in their early life; and hence it is only by watching the mode in which a cell becomes developed, that its true nature can at all be ascertained. Of course human knowledge has not extended so far as to permit of any reason being assigned why one cell should be capable of producing every tissue required to build up the body, and why another should never pass the simple form of an epithelium cell. The facts in regard to development are ultimate facts, and the great principles put in force during organization are utterly unknown. The circumstances necessary for commencing and carrying on cell development have been partially ascertained: these are—

1*st*, A nutritive blastema of proper quality and in sufficient quantity; 2*d*, A proper and equable temperature, which must be above 32°; 3*d*, Room for expansion; and, 4*th*, A proper locality.

Understanding that the presence of these four conditions is really essential to cell growth, the practical application of our knowledge ought to affect the progress of disease. If scrofula is a poison that acts most powerfully upon diseased blood, then by proper food and air the vital fluid may be changed so much that the poison can no longer exist in it; certainly as the health of the blood increases, syphilitic poison departs. The action of specifics ought to produce such a change in the composition of the blood as to render it no longer fit to nourish a poison. But do they?

1*st*, By the application of heat, the growth of pus cells becomes more rapid, and so the maturation of an abscess may be hastened. 2*d*, By the application of cold and pressure, cell growth is obstructed, and so inflammatory exudations may be discussed.

The development of Cells. A little round or oval body called a nucleus first appears in a blastema; a delicate membrane is deposited upon its surface; fluid is then absorbed between the nucleus and its investing membrane, and the latter expands, leaving the nucleus attached to one part of its inner surface.

After the cell has become fully developed, all sorts of changes may take place in the nucleus.

In the first place, it may become detached and float loose within the cell cavity, and here it may undergo further change; or may disappear altogether, perhaps by being melted, as in the case of fat cells, superficial epidermic cells, and cells of nails. If the cell wall burst, then of course the nuclei become free, and are in this state susceptible of further change, if the circumstances be suitable.

But instead of cells being developed upon a nucleus in the way that has now been described, they may be produced by the simple expansion of nuclei; and then the fluid contained within the cells so formed may become organized into a new generation of nuclei, which in turn may undergo the same changes. But after all, the formation of nuclei resolves itself into the solidification of a fluid.

It is also certain that either nuclei or cells may be formed by the aggregation of granules into a globular mass, and by the subsequent melting together of the outer layer to constitute a cell wall. Moreover, by the simple expansion of a microscopic granule a cell may be formed.

These are all the modes in which cells are developed.

IV. **Fibres.** There are four distinct kinds o fibres, namely, white inelastic, yellow elastic, non-voluntary muscular, and voluntary.

1. *White fibrous Tissue*, although in general soft and pliant, is strong, unyielding, and inelastic, and consists of delicate, wavy, and transparent fibres 1·20,000th of an inch in average diameter. These fibres neither split nor anastomose, but have the most varied arrangement; and, according to their purpose, are collected into bundles concentrically arranged around cavities, or intersect one another in every direction. This tissue is never unmixed with yellow elastic. Acetic acid causes the white fibres to swell up, and reduces them to a jelly.

2. *Yellow elastic Tissue* is in the highest degree extensible and elastic, but by no means so strong as the white, and is not at all affected by acetic acid. It is composed of transparent fibres that have a very dark and well defined outline, and an average diameter of 1·7500th of an inch.

These fibres are not arranged in regular laminæ and fasciculi, nor do they present the relaxed and wavy appearance so characteristic of inelastic fibres; but for the most part they run side by side with bold curves in a longitudinal direction, and divide into branches that break across, and curl up, and intertwine, and anastomose with one another in a reticular manner. The yellow elastic is never quite unmixed with white fibres.

3. *Non-voluntary muscular Tissue*, when fully developed, consists of prismatic or flattened ribband-like fibres, which are lacerable, break transversely, and have an average diameter of 1·3000th of an inch. These fibres are clear and granular; but their outline is delicate, and by no means dark, as in yellow elastic tissue. They are generally nucleated, but often appear to be uniform. The nuclei are of course better seen after the action of acetic acid.

The continuous or interrupted striation observed in some of these fibres, but most perfectly in those of the heart, is caused by an unusually regular arrangement of the granules which they contain.

Combinations and Position of these in the Textures.—The yellow elastic fibres interlace with and wind spirally round the plates and bundles of the white fibrous tissue. These bundles and plates are bound closely side by side to form tendons and ligaments; are firmly interwoven to constitute aponeuroses of attachment and thick fascias; or are densely matted together, as in the case of the dura mater, the sclerotic coat, and the tunica albuginea of the testicle. Very little of the elastic tissue exists in any of these structures.

In areolar tissue the bundles are loosely interwoven, and it contains more of the yellow elastic tissue. Areolar tissue is the general investing and connecting membrane of the body. It connects the skin, the serous, and the synovial membranes to the tissues that surround them ; unites the component parts of the glandular and other organs ; and fills up the interstices between them. It is unusually thick, and contains a large amount of elastic tissue in the capsule of the spleen.

The fibrous structure of the true skin, the dartos of the scrotum, and the cellular sheaths of the glands, veins, &c. either contain muscular tissue in addition to the elastic, or else they have contractile fibres of a peculiar kind, that have not the characters of non-voluntary fibres.

In a nearly pure form yellow elastic tissue constitutes the ligamenta subflava, the stylohyoid, thyrohyoid, and cricothyroid membranes, as also the true vocal cords. It extends under the mucous membrane of the trachea and bronchial tubes in the form of longitudinal bands, finally spreading over the air cells ; also in the form of longitudinal bands it supports the mucous membrane of the gullet and rectum, and forms a thin layer over the muscular substance of the former. Finally, it is also found in large quantity in the middle coat of the larger arteries, as many as thirty or forty layers being found in the aorta. In other situations it is so mixed with white fibrous tissue, that it no longer imparts its distinctive colour to the tissue.

It is in their reticular arrangement that non-voluntary muscular fibres so much resemble the tissues just described. Non-voluntary muscular fibres are found surrounding the whole alimentary canal, from the middle of the œsophagus to the external sphincter ani. They form the middle coat of the smaller arteries; are found along all the air-tubes (but not in the air cells). They constitute the muscular structure of the heart, pregnant uterus, and bladder; and exist, though in a less marked degree, on the gall-bladder, ureters, all the large, and most of the small gland ducts. Except in the heart, where the muscular fibres are peculiar, the mode in which these fibres terminate and are attached is entirely unknown. They are collected into fasciculi of various sizes, which interlace and exchange fibres with one another; but they always run either along or across the tubes or hollow organs which they surround, and have a capillary net-work similarly disposed. There is very little areolar tissue intermixed with these fibres; and indeed their mode of arrangement precludes the necessity of a uniting tissue. Their nervous supply is derived from the sympathetic system.

The muscular fibres of the heart are intermediate in size between the voluntary and the ordinary non-voluntary fibres. They are also darker in colour, and are attached to the tendinous rings of that organ. In rapidity of contraction they surpass all other non-voluntary fibres.

4. *Voluntary muscular tissue* consists of parallel fibres collected into bundles, and attached at either extremity by tendons. The ultimate fibres are 1·400th of an inch in average diameter. Each primitive fibre consists of a delicate membranous tube, called *Sarcolemma*, which is polygonal in form, and filled with cylindrical fibrillæ, imbedded in a clear gelatinous fluid. These contents are called *Sarcine.* The sarcolemma is structureless, and marked here and there by nuclei; and the fibrillæ, of which there are several hundreds in each tube, have nuclei imbedded among them. The fibrillæ

are 1·18,000th of an inch in diameter, and are divided into segments by delicate transverse lines 1·10,000th of an inch apart. Each segment is of course rectangular, and consists of a dark central part, shaped like a dice-box, surrounded by a clear border. The segments of all the fibrillæ correspond with one another, as they lie side by side; and their dark centres produce the transversely striated appearance observed in voluntary fibres. The fainter longitudinal striæ correspond with the line of separation between the parallel fibrillæ. The fibres terminate abruptly; that is, by a flat extremity, against which is attached a little bundle of white fibrous tissue, which constitutes its tendonous termination. A single white filament is attached to each fibrilla, and a few are connected to the sarcolemma. The fibres are collected into primitive fasciculi by delicate areolar tissue, and these again into larger and larger masses, which are aggregated to form a muscle. The arteries form an elongated net-work corresponding with the direction of the fibres; and the nervous fasciculi, which are derived from the cerebro-spinal system, separate into their primitive tubuli, spread out into loops that lie in contact with the fibres, dip between them, and return either to the same fasciculus from which they were derived, or to some other one. But, it must be remarked, that they never perforate the sarcolemma.

Voluntary muscular fibres contract instantaneously on the application of a stimulus, either to their own substance or to the nerve that supplies them ; but the contraction is of momentary duration. Contraction is not attended by any diminution in the volume of the muscle, but appears to be merely a change in its form. Each fibrilla simply becomes shorter and wider, the amount of shortening being about one-third of its length.

The force of Muscular Contraction has been variously estimated at from 15 to 500 pounds for each square inch of surface presented by the cross section of a muscle: this estimate of the ordinary force does not apply to contraction taking place under great excitement.

All the fibres in any one muscular fasciculus do not contract at the same moment; and, consequently, the uncontracted fibres exhibit a festooned appearance, which makes the muscle assume a zigzag outline.

The fibres are thought to relieve one another by their alternate contraction during continued exertion.

The contraction of voluntary fibres is indeed the type of all such actions; and according to the fulness of nervous supply given to the non-voluntary fibres, so their contraction the more nearly approaches that of the voluntary in its rapidity. It must not be forgotten that the heart is supplied with cerebro-spinal as well as by sympathetic nerves.

Ordinary non-voluntary fibres contrast very strongly with voluntary in their excitability. Those of the gall-bladder and ureters are with great difficulty forced into even slight contraction; those of the heart are most excitable; and contraction becomes less and less vivid, as the pregnant uterus, vas deferens, the small and great intestines, the bladder, iris, cœcum, and stomach, are successively tried.

The remarkable peculiarities in regard to the contractions observed in this tissue are,—1*st*, That the influence of an irritant extends to the fibres surrounding the irritated part. 2*d*, That the contractions occur slowly. 3*d*, But especially that after ceasing, they sometimes recur at regular intervals, after the irritation has been quite removed.

The amount of shortening may greatly exceed that of the voluntary fibres; and generally the longitudinal set of fibres act first.

The mode in which individual fibres contract is entirely unknown.

The Rigor Mortis comes on usually within seven hours after death; the rigidity begins in the muscles of the neck and lower jaw, and affects the lower extremities last of all. As soon as it has fairly departed, putrefaction immediately follows. It comes on most quickly, and lasts shortest time after death by some chronic exhausting disease; and the reverse is the case when a strong man has died of some rapidly fatal affection. Rigor mortis occurs both in voluntary and non-voluntary muscles, and the firmly contracted state of arteries after death is one variety of this phenomenon, and passes off like that of other muscles. Its cause is quite unknown.

V. TUBES. The tubular tissues are four in number, namely, the Nervous, the Capillary, the Absorbent, and the Dental.

1. *Nerve Fibres* are of two kinds, namely, the white and the grey. The white fibres are delicate tubes of about 1·2000th of an inch in diameter, but some are larger than this, and others

do not exceed 1·12,000th of an inch. Each fibre consists of a delicate tube called *Neurilemma*, containing an oily fluid called *Neurine.* This fluid, after removal from the body, separates into a firm external part, which is the *medullary sheath*, and leaves the fluid called *Axis Cylinder* in the centre. A fresh fibre therefore appears to be bounded on each side by a single dark line, but after a little, two lines appear on each side, and the axis cylinder may protrude at the broken extremity of the tube. The white fibres in the brain are remarkable for their varicose appearance; but whether the alternate sacculations and constrictions which they present are really natural, or are the result of pressure between the glasses, it is very difficult to say. In the brain the fibres are certainly more delicate than elsewhere. Nerve fibres are merely the conductors of stimuli to or from the nervous centres; they cannot originate any nervous force whatever. But it is especially remarkable that there are two distinct sets of fibres existing in the cerebro-spinal nervous system—the sensory or incident fibres which convey irritation only *towards* the nervous centre, and the motor or reflex fibres, which conduct influence only *from* the nervous centre. It is perfectly impossible for the one set to perform the functions of the other. It must not be imagined, however, that any difference of appearance can be detected in these fibres. When an irritation is applied to a sensory nerve, and conveyed by it to a nervous centre, this irritation may be reflected—that is to say, changed in direction—by the nerve-cells, and may produce muscular action, which is, from the mode of its production, called *reflex*. But it is perfectly impossible for a sensory to affect a motor nerve in any other way than through the agency of nerve-cells.

The grey fibres are generally smaller in diameter than the white, and have the same size, and nearly the same appearance as non-voluntary muscular fibres. By some physiologists they are thought to be the nervous fibres peculiar to the sympathetic system; but by others they are considered to be only cellular tissue. Excellent arguments are advanced on both sides; but the general opinion leans towards the idea that they are really nerves. They constitute the greatest part of the sympathetic system, to which they impart a greyish colour.

The mode in which nervous fibres terminate is only ascertainable in the case of the white variety.

First, they terminate in loops, as in muscle, skin, &c.; secondly, they terminate in a delicate network, as in serous membranes; thirdly, they terminate in free extremities in the pacinian corpuscles. In the retina they form a net-work at the back part of that structure, but anteriorly they appear to melt together into a continuous membrane.

2. *Capillaries* vary in diameter from 1·1000th to 1·5000th of an inch. They are delicate tubes which present longitudinal and transverse nuclei, with a double outline when above 1·2400th of an inch, but have a single outline, and transverse or irregular nuclei only, when below that size. Whether they be considered muscular or not, they are certainly highly gifted with contractile power. They are supposed to be under the influence of the sympathetic system of nerves; but the mode in which these nerves are distributed to, and influence them, has never been observed, and therefore, this is mere matter of speculation; yet, it is perfectly certain, that they are under nervous influence, for powerful affections of the mind will cause them to contract or relax in the most remarkable manner, as is amply testified by pallor of the countenance, blushing, &c. They are cer-

tainly the most important organs in the hun body, for through their walls must transude, only all the material for the regeneration of tiss but all the poisons that are eliminated by t gland cells. It is only by their spasmodic co[illegible] traction under mental or other causes, that t[illegible] entire stoppage of secretion at the mamma, liv[illegible] or kidney can be accounted for. Their spas[illegible] subsequent relaxation, and final loss of tone accompanied by the transudation of their contents, are indeed the ultimate facts which constitute inflammation.

The forms assumed by the capillary net-works, are varied and beautiful, suiting themselves admirably to the organs they supply. In the liver they converge from nearly all the surface of the acini into one central vessel. In the kidney, they are convoluted into the glomerules of Malpighi, and again collected and re-distributed upon the tubuli uriniferi. In the intestinal villi, they form a conical net-work, and their distribution in nerves, in muscles, and in other organs, is so peculiar, as at once to detect the nature of the structure in which they are found.

The capillaries are smallest in the brain, small also in the lungs and in muscle, larger in the skin and mucous membranes, and largest of all in the medullary membrane.

The arterial coats are six in number, although all of them may not be detected in every vessel. First, there is a single layer of epithelium lying in contact with the blood; second, a delicate, transparent, and fragile membrane, marked by branched nuclei lying transversely, and perforated here and there by oval or rounded openings; hence called by Henlé the fenestrated or striated coat. There may be several layers of it, but sometimes it is absent altogether. Third, one or more layers, most likely composed of longitudinal fibres, and marked by elongated nuclei, which are not affected by acetic acid. The muscularity of this coat is still disputed. Fourth, the circular fibrous layer is composed of short transverse nucleated fibres. The thickness of this layer varies greatly according to the size of the vessel. Fifth, the yellow elastic layer. Sixth, condensed fibro-cellular tissue (areolar).

Veins want the yellow elastic layer, but have a thinner circular, and a thicker longitudinal fibrous coat. As the arteries branch and diminish in size, the yellow elastic layer first is lost, then the fenestrated layer disappears, although it may be seen in arteries 1·60th of an inch in diameter. Next the epithelial layer vanishes, so that a very sm artery consists merely of a cellular, a circular, an longitudinal coat. When the cellular coat is lo then the vessel verges into a capillary; a finally, the very small capillaries, which are cap ble of transmitting only a single blood corpuscle at a time, consist of only one coat, and that is the circular.

The real nature of the circular fibrous coat is disputed, but the prevailing idea is that it is almost exclusively made up of yellow elastic fibres in large arteries, in which it attains a great thickness (15 to 40 layers); but that in small arteries, which are deficient in yellow elastic tissue, this coat is almost entirely muscular. The effect of torsion upon small arteries sufficiently proves the muscularity of this coat in these.

3. *Absorbent vessels*, as they are commonly observed, are very uniform in diameter, being rather larger than the largest sized capillaries. Their membrane is highly contractile, perhaps more so than that of the capillaries themselves—at least lymphatic vessels 1·20th of an inch in diameter, contract more powerfully than arteries of the same size. Their commencing net-works, unlike those of the ultimate capillaries, cannot be

distinctly seen,—the only approximation to a correct idea being founded upon the appearance which they present in the structure of the scrotum and subcutaneous cellular tissue of the breast near the nipple. Their commencement, according to Goodsir, and other first-rate authorities, is in intercellular passages.

The larger vessels consist of a cellular external coat, an epithelial internal one, and a middle fibrous layer, which, however, is formed mostly of longitudinal fibres. Like veins, these vessels are furnished with valves, but at shorter distances. Some lymphatics, however, have no valves. The vessels that do possess them have often a jointed like appearance, and whether or not lymphatics pass through absorbent glands in their passage to the thoracic duct, their character is the same. A valve is placed at the entrance of the thoracic duct into the left subclavian vein, and the entrance of the right lymphatic duct into the right subclavian vein is guarded in a similar manner. There is really no difference between lacteal and lymphatic absorbents, except in the quality of the fluids which they convey.

4. *Dental Tubes.*—The principal mass of a tooth consists of dentine, through which tubes

1·4500th of an inch in diameter radiate in nearly parallel lines from the pulp cavity to the surface. Above the level of the gum the hexagonal fibres of the enamel are implanted at right angles upon the dentine; and below the gum the crusta petrosa, which is identical with the structure of bone, closely embraces the fang. The delicate branches of the dental tubes, especially those near the surface, are immeasurably fine. The pulp cavity is occupied by a semifluid substance, in which is a delicate vascular and nervous loop. The enamel fibres are 1·500th of an inch in diameter, and some think they are tubular. The canaliculi and lacunæ of the crusta petrosa are perhaps continuous with the dental tubes. However complex may be the details of the process by which teeth are formed, its essential part is the folding of mucous membrane into a sac containing pulp. The pulp is changed into dentine. The upper part of the tooth-sac developes the enamel from its inner surface, and the tooth-sac itself becomes ossified into the cement or crusta petrosa. When the tooth erupts, the cement lying on the crown is of course quickly rubbed away, and then the hard enamel comes into use.

In enamel there is 96½ per cent. of earthy matter, chiefly phosphate of lime with carbonate of lime, phosphate of magnesia, and other salts; but the cement and dentine contain less mineral matter.

In this place, I shall consider the elementary structure of bone, which, according to the best authorities, is of a fibrous nature. Bone consists of calcified gelatinous fibres, 1·20,000th of an inch in average diameter, closely interwoven into osseous plates, which are concentrically arranged to form the walls of Haversian canals in the shaft, and of cancelli at the articular extremities of long bones. The superficial osseous plates are arranged concentrically with the medullary cavity. The lacunæ are spaces between the plates where the latter do not lie in close contact; and the canaliculi are minute tubes radiating from the Haversian canal to the lacunæ, and from the lacunæ again to one another, and to the surface. These canaliculi are formed by the exact correspondence of the little quadrilateral intervals left by the crossing of the elementary fibrils forming the osseous plates.

The Haversian canals, which are about 1·500th of an inch in diameter, are short tubes having a reticular connection with each other, and conveying the nutrient system of vessels through the bone.

Some contain both an artery and a vein, but the arteries and veins usually run in different canals. Nucleated cells intervene between the contained vessel and the containing canal; and it is the liquor sanguinis alone that passes along the canaliculi into the lacunæ; and that it does pass has been sufficiently proved by mixing colouring matter with the food of animals, and observing the effects in their bones. It must be here remarked, that as the vessels are well supported by the Haversian canals, their coats are remarkably thin, and in this way beautifully fitted for transuding the liquor sanguinis requisite for nourishing the bone. Considering the relation of the osseous matter to its vessels, it is not surprising that all morbid changes should commence in the Haversian canals alone. Hence it is that intersticial absorption, the forerunner of caries, produces a worm-eaten appearance in the osseous structure. The medullary cavity and the larger Haversian canals are lined with delicate cellular tissue, in which the vessels are ramified, and the fat cells of the marrow are deposited. But the latter is not fully developed until adult age; and in childhood the medullary cavity is occupied by a sanious jelly-like fluid.

The periosteal covering of bones is very dense, and well supplied with bloodvessels, and is a highly important organ, not only for the nutrition of the bone, but for the attachment of tendons, &c.

The earthy salts contained in bone are the same as those that give firmness to teeth. Bone phosphate of lime ($8CaO, 3PO^5$) constitutes 50 to 60 per cent., and gelatine 29 to 34 per cent. of the entire bone. In the remaining part traces of iron and manganese may be detected.

In the bones of adults the proportion of animal to earthy matter is as 1 to 2 ; in those of children as 1 to 1¼ ; in old persons it may be as 1 to 5 ; and in rickety children it may be as 4 or 5 to 1.

Original formation of Bone.—Ossification is intra-membranous in the bones that form the cranial vault, and intra-cartilaginous in those of the extremities, &c. In the former case, the ossific deposit appears to be thrown out in a radiating manner, without any obvious preparation being made by the membrane to receive it. In the latter case, the cells of the ossifying cartilage which had an irregular arrangement previously to the commencement of ossification, immediately arrange themselves in rows converging towards the ossifying centre. The granular osseous matter is poured out, as before, into the hyaline blastema, between the piles of cartilage cells. The latter melt down, and are supposed to form the Haversian canals; and their persistent nuclei remaining embedded in the osseous substance, are the causes of the separation between the osseous laminæ of the Haversian canals constituting the lacunæ. These indeed have a diameter of 1·1000th to 1·2000th of an inch, which corresponds well with the size of the nuclei of cartilage cells. The changes that take place from the primary ossification to the perfect development of bone are quite unknown.

Reproduction of Bone.—If the periosteum be entirely removed for the extent of several inches from the shaft of a long bone, the denuded portion dies. If the same extent of the shaft itself be removed, but the periosteum remain continuous above and below with the rest of the shaft, then regeneration will take place, and the vacuity will be filled up by new bone. From these facts some have concluded that regeneration is due to the periosteum alone. The first physiologists, however, declare that *all* the tissues of healthy bone assist in reproduction of the part removed.

Reunion of Bone.—When a bone is fractured, the lacerated vessels of the surrounding parts, as well as those of the bone itself, pour out blood which distends the soft tissues, and forms a sac around the fractured extremities. The colouring matter of the blood is gradually absorbed, and a jelly-like mass remains; but it is not known whether this is the remainder of the extravasated blood or a new exudation of plastic lymph. At all events, the surrounding parts not only become more vascular, but contract in such a manner as greatly to diminish the cavity of the sac. The jelly-like mass attains a cartilaginous consistence, and then becomes ossified; so binding the as yet ununited extremities firmly together. This is the splint supplied by nature, and is called the Provisional Callus. Ossification commences at the periosteum in contact with the original bone. The extremities are, as yet, ununited, but have been gradually becoming softer and more vascular. The vessels of the bone itself now finally pour out the lymph that is to be developed into the true connecting osseous matter. As usual, the denser structure so formed, becomes gradually opened up during its development, and the cavity which was at first closed, again becomes pervious. The material that actually unites the fractured extremities is called the Definitive Callus.

VI. MEMBRANES.—It is only to such delicate films as the hyaloid, the cornea elastica, and the basement membrane, forming the characteristic tissue in the compound membranes, that the term Structureless can be justly applied. The compound membranes are the serous, the synovial, and the mucous, to which may be added the skin.

There are five serous membranes in the body; the Arachnoid, the Pleura, the Peritonæum, and the Tunica Vaginalis Testis.

The arachnoid and dura mater are fibro-serous membranes, but the others are serous only. They are all very thin and delicate, extremely sensitive, and moistened with a faintly alkaline fluid identical with the serum of the blood. There is supposed to be an intricate plexus of nerves in the areolar tissue that supports their basement membrane, and they are also freely supplied with blood-vessels. The synovial structure does not differ from the serous, except in the density of the fluid it contains; and it must not be considered as a settled matter that the synovial membrane really extends any further than the margin of the articular surfaces. The stratified epithelium, said to exist on these last, is only the superficial layer of cartilage cells. The synovial membrane is sometimes pouched to contain little soft masses of fat.

Mucous Membranes are the type (pattern) of all membranes, consisting as they do, 1*st*, of a basement membrane (which sometimes does, and sometimes does not, contain persistent nuclei); 2*d*, of a supporting cushion formed of areolar tissue, blood-vessels, &c.; and, 3*d*, of a protecting structure, called Epithelium, which is thicker the more it is exposed to pressure or friction. But mucous membrane is of more consequence than any other in the body; first, because it is the only membrane that comes in contact with the food, which it absorbs by means of its villous projections; secondly, because all the glands, except the mammary and cutaneous, are formed by its sacculation in a more or less complicated manner; of course, exception is to be made for the liver, in which the ducts most probably commence by intercellular spaces; but all other glands, even those of the mammæ, may be included under one of two classes, namely, the Follicular and the Tubular. The former have every degree of complexity, from the simple lenticular follicles scattered over the stomach and great intestine to the complex salivary glands or pancreas. The latter class comprehends all those glands in which the mucous membrane assumes a purely tubular form.

The Skin consists of cuticle and cutis vera; the former composed of epithelial cells, the latter of contractile fibro-vascular tissue, with nervous and absorbent plexuses. The newer and more pulpy layers of epithelium constitute the rete mucosum, as it used to be called, and contain pigmentary matter, which, by its accumulation, causes the different shades of colour observed in the various families of the human race. The entire thickness of the cuticle varies from 1·12th to 1·20th of an inch. The cutis consists of a vascular papillary layer, which is exquisitely sensitive, and of the corium, which is very dense, and becomes gradually blended with the subcutaneous areolar tissue. The corium varies in thickness from the 1·50th to the 1·8th of an inch. In the subcutaneous cellular tissue are hair follicles, sebaceous and sweat glands. The sebaceous glands open into the hair follicles, and consist of from five to twenty delicate little saccules, lodged in the substance of the corium, and terminating in a single duct which opens into a hair follicle a little way within its mouth. The hair follicles are in reality sacculations of the corium; the cuticular covering of which is produced in very large quantity at the bottom of the follicles, and forms the hair. The central part of the hair consists of epithelium which has become fibrous in structure, and the superficial coating is formed by delicate imbricated cells which give its outlines a serrated edge. The widest part or bulb of the hair occupies the hair follicle, and often a considerable amount of granular matter is found in the bulb and lower part of the stem. Of course hairs are solid. The sweat glands are small reddish-looking bodies, consisting of a convoluted tubule, situated in the subcutaneous fatty tissue. The duct ascends spirally through cutis and cuticle, is slightly curved as it passes through the corium, and twisted like a cork-screw in its transit through the epidermis. Although basement membrane cannot be demonstrated in the true skin, yet it forms a distinct element in the walls of the sweat ducts.

In addition to the ordinary physical properties of hardness, strength, and elasticity, the textures—at least the membranous ones—possess the property of allowing fluids to transude through them. When a membrane is interposed between a thick and a thin fluid, the thin fluid quickly transudes and mixes with the thick. Transudation of this kind, from a membranous cavity, is called Exosmosis, and transudation into a membranous cavity is called Endosmosis. It is absolutely necessar that the fluid on the two sides of the membran shall be perfectly miscible with one another; an of all solutions, that of albumen transudes wit greatest ease; and this is a very significant fact i regard to the use of albumen in the animal ec nomy. It must not be supposed that the proce of cell-growth is merely the result of endosmosi for the cell-wall and the cell-contents grow togethe and appear to have the same density as the su rounding fluid.

Contractility and sensibility, manifested b muscles and nerves, are the only tangible prope ties that can be fixed upon as of a truly vital kin The changes of organization are so mysterious, ar so subtile in their accomplishment, that it is almo useless to engage in any discussion about them.

FUNCTIONS.

THE FUNCTIONS of the HUMAN BODY are N trition, Innervation, and Reproduction.

I. Nutrition includes not only digestion, a sorption, sanguification, and secretion, but al respiration and circulation, which are justly co sidered as being perfectly vital.

THE CONVERSION OF FOOD INTO BLOOD is a chemical process, as far as the intestinal villi, but a vital one beyond these.

The food of man must contain saccharine, oleaginous, and albuminous principles; and to these the gelatinous may be added with advantage.

The fluids that exert a chemical action on the food, are Mucus, Saliva, Gastric Juice, Pancreatic, Brunnerian, and Biliary Fluids; perhaps also the fluid of Peyer's glands may assist.

Mucus is generally alkaline, but in the cœcum it is acid.

Saliva is a viscid alkaline fluid, containing epithelium cells and salivary globules, and remarkable for frothing up and retaining air bubbles. It contains 2 per cent. of solid matter; one half being a nitrogenous ferment, called Ptyaline, the other half salts, among which sulphocyanide of potassium is peculiar to saliva.

Pancreatic Juice has a similar composition, but its reaction is unknown. It contains four times as much solid matter, but no sulphocyanide.

Gastric Juice is an acid consisting of a nitrogenous ferment, called Pepsine, in union with free acids, chiefly the phosphoric and lactic. As a number of salts exist in gastric juice, it is nearly impossible to decide with which of them the acid is associated.

Brunnerian Fluid is unknown in the separate state.

Bile is supposed to be neutral. It has a golden yellow colour, with a slight tinge of green. According to some, it is the choleate of soda, and certainly it contains a large quantity of sulphur.

Saliva converts boiled starch, first into dextrine, then into sugar, and finally changes this, or any other sugar, into lactic acid.

Gastric juice dissolves all albuminous and gelatinous tissues, reducing the former to degraded albumen, the latter to degraded gelatine. If albumen or caseine be introduced into the stomach in a fluid state, they are first coagulated, and then dissolved.

Pancreatic juice is supposed to dissolve the oil in the most perfect manner.

The action of bile is entirely unknown, and the same observation may be made with regard to Brunnerian fluid.

The experiments of Bernard would have gone to prove that bile is able to convert any kind of food into sugar, oil, and fibrine ; but his experiments have not been confirmed. It is imagined that the bile may act as an *antiseptic* in preventing further decomposition of the food, and by partially decomposing, may produce the alkalinity of the chyle, which seems necessary for its easy absorption.

The intestinal mucus, no doubt, does produce some chemical action on the food, but its nature is not known. As a lubricating fluid its use is obvious.

The bloodvessels, themselves imbibe a large amount of liquid. Whenever the remaining perfectly fluid food has become absorbed by the development of the nuclei that occupy the free extremity of the intestinal villi, changes of a vital nature begin to take place. Between the villi and the mesenteric glands the chyle is a milky fluid, and consists of a molecular base of oil granules, degraded albumen, and dissolved salts; it is not coagulable, either spontaneously or by the aid of heat, and it is destitute of cells. Whatever be the change that takes place within the mesenteric glands, it is quite certain, that no sooner has the chyle passed them than it is coagulable, both spontaneously and by heat; and likewise, it has floating in it the chyle cells, which so much resemble the colourless corpuscles of the blood; it is also less milky. The nearer it approaches to the left subclavian vein, the clearer, the more coagulable, and the more pregnant with cells does it become.

When absorption is not going on, the fluid in the thoracic duct and lacteals is clear, and resembles the contents of the lymphatics ; it is indeed very similar to diluted liquor sanguinis.

So much then for the change of food into blood ; and now what changes take place in the blood itself?

It must be remarked that the chyle is thrown among the *venous* blood, namely, that which can no longer nourish the body, and is carried along with it into the lungs ; and, no doubt, undergoes in these organs the final change required for its conversion into perfect blood. To effect this change, contact with the blood is essential ; for chyle itself, exposed to contact with atmospheric air, would not become perfect blood.

When the dense and deep purple venous blood has changed into bright red arterial, then it is fit for nourishing the body. But what change is effected at the lungs? Why, carbonic acid gas and watery vapour are given off in such quantity, that, in twenty-four hours, not less than from 8 to

11 oz. of pure carbon, and 16 oz. of water pass away.

It is only at the tissues, that is to say, at the capillary distribution of the vascular system, that the changes of nutrition take place—and, consequently, it is chiefly to the tissues that we must look for an explanation of such a serious change as that of arterial into venous blood. First of all, it must be remembered that the fluid existing in the muscular tissue is strongly acid; while, as we well know, the blood within the capillaries is decidedly alkaline. Now, some chemists suppose that, by the transmission of a galvanic current through the capillary membrane, the lactic acid contained in the juice of flesh becomes decomposed and resolved into carbonic acid and water; if this view be correct, there is an easy way of accounting for the carbonic acid existing in the blood. But, as a large amount of oxygen gas is taken in at the lungs, and as one-third of it never appears to return, it must, to all intents and purposes, have combined, either with the elements of the blood itself, or with those of the tissues that are supplied by that fluid. As the blood permeates the tissues, they extract from it whatever material they require for their regeneration and growth. The liquor sanguinis is transuded in a quantity not greater than is exactly required. Each tissue is capable of forming the same liquor sanguinis into its own substance; and this is one of the most wonderful and inexplicable facts in regard to nutrition. But the tissues of the various organs are continually undergoing decay and disintegration; their melted substance is constantly returning into the blood, and their mode of entering the circulation, no doubt, differs in different substances. The absorbent vessels bring back lymph from nearly the whole body and pour it among the blood; but what this lymph is derived from cannot be made out.

The sum of our knowledge then, on the subject of nutrition, may be thus stated:—

1*st*, *In regard to absorption*, all food must be perfectly liquified before it can be permitted to mix with the blood. The accidental entrance of solid matter is carefully provided against by the interposition of a basement membrane. Fluids enter the blood by three channels, namely, *Capillary Bloodvessels*, *Lacteals of the Villi*, *and Lymphatics of the system*. Capillaries will absorb any fluid whatever that is perfectly miscible with the blood; and water is absorbed chiefly by them.

Lacteals do not absorb any thing that has not been acted on by the digestive fluids. Lymphatics are supposed to absorb either the superabundance of exuded lymph, or the melted principles of the tissues; but they do not exist in the brain and spinal cord, in the placenta, the eye, nor in most of the bones, cartilages, and fibrous tissues.

2d, In regard to chemical and vital changes in the Blood and in the Tissues.—The formation of new tissue is constantly in progress in all organs except the least vascular; and a corresponding disintegration of their substance appears to be the invariable result of life. The melted tissue, whether absorbed directly by the capillaries, or indirectly by the lymphatics, finally mingles with the blood.

The nature of the change effected on the blood by atmospheric oxygen is difficult to determine. The ultimate facts are these: carbonic acid rather less in amount than the absorbed oxygen is given off at the lungs; the venous blood (sp. gr. 1057) is changed into arterial (sp. gr. 1052), and its fibrine becomes insoluble in solution of nitrate of potash.

But if facts are scanty, theories are plentiful; and accordingly, it is acknowledged by every one that oxygen causes slow combustion within the body, and thereby not only assists in the formation of secretions, but very well accounts for the production of animal heat. It is impossible to say which of the changes constantly going on in the blood are vital and which chemical; for chemical and vital changes are inseparably connected with the existence of animals. But very probably the formation of urea, uric acid, and carbonic acid in the blood, of kreatine, kreatinine, and inosinic acid in the tissues, and of extractive matters everywhere, is the result of *chemical* rather than of vital action. The formation of some secretions, however, may very likely be in a great degree vital.

But how is the carbonic acid conveyed from the tissues to the lungs? Liebig asserted that it was by the iron of the hœmatine; and that the carbonate of the protoxide existed in venous blood, while hydrated sesquioxide was present in arterial; and that the sesquioxide became converted into the protocarbonate by losing its oxygen, oxidizing the tissues, and coming back to the lungs with the resulting carbonic acid.

Without being certain that this view is altogether wrong, it is by no means very satisfactory; and therefore the present view may assist, if it cannot entirely explain, the conveyance of carbonic acid. The alkaline phosphate of soda existing in the blood absorbs the carbonic acid at the tissues, conveys it to the lungs, and there, in presence of atmospheric air, gives it off, but leaves the blood itself to absorb the oxygen from the atmosphere.

THE PRODUCTION OF ANIMAL HEAT.—Animal heat is produced,—

1*st*, By the combustion of lactic acid, of bile, and of the carbon, hydrogen, sulphur, and phosphorus of melted tissues by atmospheric oxygen ; and this may take place either at the tissues or in the blood, but most likely in both.

2*d*, By the combustion of the saccharine and oily matters of food.

3*d*, By chemical decomposition, independent of combustion, and perhaps caused by animal electricity.

4*th*, By vital processes.

5*th*, By muscular contraction, and by the resilience of arterial coats ; perhaps even by the friction of the current which they transmit.

6*th*, Nervous influence seems to be essential to the maintenance of animal heat, and so may be a number of other things scarcely even dreamt of.

Composition of the Blood.—1000 parts of healthy blood contain 210 parts of solid matter, and 790 of water. The solids consist of 120-130 of yellow corpuscles, 70-80 of albumen, 2-3 of fibrine, 2 of oil, 4 of extractive matter, and 7 of salts. But of these ingredients the corpuscles, albumen and fibrine, are vicarious of one another; for as the one increases the others usually diminish. Still there are instances in which the solids have amounted to 480 parts in 1000 of blood.

The oily matter of blood consists of serolin, phosphorized fat, cholesterine, and saponified oleine and margarine.

The salts consist of phosphates of soda, lime, and magnesia, chlorides of sodium and potassium, with sulphates, lactates, and carbonates. The state of the dissolved iron has not been determined.

Besides the ingredients already stated, all matters existing either in the solids or fluids of the body, exist in minute quantity in the blood. A trace of urea is always present; and in the blood of suckling females, caseine may always be detected. But urea accumulates in Bright's disease; biliary matter in jaundice; sugar may be foun in diabetes, urate of soda in gout, and animalcu have been seen in typhoid fever. Living blood consists of corpuscles floating in liquor sanguinis; but coagulated blood consists of clot and serum. Serum is a straw yellow-coloured fluid, sp. gr. 1028, and contains all the ingredients of the blood except fibrine, coloured and colourless cells. These last, of course, are contained in the clot.

The coagulation of blood is thought by some to be its last vital act, but this is denied by others; coagulation begins in about seven, and is perfect in ten minutes after it is drawn; the result is a tremulous jelly-like mass. The net-work of fibrine then gradually contracts upon the entangled corpuscles, and squeezes out the serum; and this contraction may go on for twenty-four or even forty-eight hours.

Coagulation is accelerated by cold, not below 40°, by rest in vessels, and by contact with rough surfaces; but more especially by exposure to air. These are evidently opposed to the conditions of blood during life; namely, warmth, continued motion along the exquisitely smooth lining of the vessels, and its complete freedom from contact with air. Of course, when blood is drawn, or when it is received in a deep vessel, it does not coagulate so rapidly as under opposite circumstances, because it is not exposed so much to the atmosphere. Arterial blood coagulates more rapidly than venous; and the blood of females more rapidly than that of males. The increased rapidity of coagulation observed during faintness from loss of blood, is truly a wise provision of nature.

It has been said that in animals hunted to death or killed by lightning, coagulation does not take place, but this statement is not true in every case. Coagulation is certainly retarded in death by asphyxia, by narcotic poisons, and by all typhoid fevers, and even one part of caustic potash or soda in 1000 of blood will prevent it altogether. In fact, anything that destroys the spontaneous coagulability of fibrine, will also prevent coagulation.

Now, what is the " Buffy Coat ? " Inflammatory blood does not coagulate so rapidly as healthy, and the corpuscles have a stronger than ordinary attraction for one another. The yellow corpuscles, which are heavy, aggregate into rolls, and these rolls form net-works which subside, leaving the principal part of the fibrine along with the entangled colourless corpuscles, as a soft crust on the surface of the red mass. The crust sometimes contracts a good deal, and then presents a "cupped" appearance.

Changes of Blood in disease.—Corpuscles are increased in plethora, and in fever they may amount to 185 in 1000 of blood; in chlorotic anœmia, they have been found at 21. The albumen is certainly increased in blanching diseases, such as scrofula and cancer; it has reached 131 in cholera, and sunk as low as 55 in chronic Bright's disease. Fibrine is increased in healthy inflammations, more particularly in those of fibrous and serous membranes: in rheumatism it has been found at 13; while in malignant fevers it scarcely exists. The salts are increased in scurvy, in which also the corpuscles lose their form, break up, and increase the amount of granular matter; but the earthy salts are diminished in rickets.

The oil seems deficient in scrofula, and is increased in milky blood.

The peculiar changes that occur in the blood in syphilis, in eruptive and other fevers, and in peculiar poisonous actions, are quite unknown.

It ought to be remembered, that along with fibrine, the white corpuscles are always included, because they cannot be separated; and that the profuse watery discharges in cholera, as well as other modifying circumstances in other diseases, may greatly vitiate the results of their examination.

The colour of blood-clot is bright from arterial, but dark from venous blood; yet, as the arterial clot can be darkened by washing it with water, and the venous rendered scarlet by washing it with solution of salt, there is great reason to think that the change of colour during respiration is owing to alterations of form in the corpuscles. Carbonic acid is found to swell them; oxygen gas to contract them.

Menstrual Blood is acid when it has passed from the vagina, but if obtained from the uterine cavity by a speculum, it is alkaline; the acid mucus of the vagina and uterus causes its acidity.

Portal Blood, when compared with ordinary venous blood, is darker in colour, lower in sp. gr., and cannot be brightened by salt or oxygen. Besides small quantities of sugar and other matters absorbed by the capillaries, directly from the alimentary canal, it has more corpuscles, half the amount of fibrine, and twice as much oil.

Hepatic Blood contains no sugar, and is very similar to ordinary venous blood. But according to Bernard, this statement is false.

The blood during hunger and thirst, by irritating particular parts of the mucous surface, causes these sensations to be referred in one case to the stomach, in another to the fauces. In support of this statement, if innutritious food be introduced into the stomach, the sensation of hunger is not appeased; neither, indeed, do the efforts at inspiration cease if the lungs are removed.

THE MECHANISM OF DIGESTION.—As man is an omnivorous animal, he is furnished with incisor teeth like *rodentia*, with prehensile canines like *carnivora*, and with molars like *herbivora*. The hands, however, are the proper organs of prehension in man; and the teeth are merely employed for cutting, tearing, and grinding the firm portions of food.

With the hyoid bone for a fixed point, the digastric, mylohyoid, and geniohyoid muscles pull down the jaw; the temporal, masseter, and internal pterygoid pull it up again; and the external pterygoid, assisted by the masseter, roll it from side to side. The external pterygoid also pulls the interarticular fibrous plate of the lower jaw forwards along with the condyle; the buccinator and the tongue keep the food under the action of the teeth. The saliva is then poured out from the parotid, submaxillary, and sublingual glands, and along with the mucus, serves not only to dilute the food into a semifluid pulp, but, by mixing it up with a large quantity of air, conveys oxygen to the stomach. When sufficiently triturated, the morsel is swallowed.

1*st*, The tongue and cheeks carry the food past the anterior pillars of the palate, and lodge it in the pharynx. This act is voluntary.

2*d*, All at once the anterior pillars close down upon the tongue, and prevent the return of food into the mouth; the posterior pillars contract upon the uvula, preventing the regurgitation of food by the posterior nares, and forming a funnel for its conduction down the pharynx; the tongue is drawn back, the larynx is pulled forwards and upwards under its root, and the epiglottis is bent over the rima glottidis, now firmly closed by its muscles; the constrictors then act in succession from above downwards. The incident nerves for this reflex action are the 5th, the glosso-pharyngeal, and pneumogastric of the 8th.

3*d*, The œsophagus then conveys the morsel to the stomach by a single wave of contraction if the food be pulpy, but by shortening of its longitudinal and successive contractions of its circular fibres if it be firm. This reflex action also takes place under the influence of the 8th.

Whenever the food has entered the stomach, the mucous membrane becomes more vascular, rises in temperature, and pours out the gastric fluid from its glands. But the food must be prevented from leaving the stomach until it be properly digested, and therefore the cardiac and pyloric sphincters close at once.

Movements of Stomach.—A wave of contraction passes from the cardiac towards the pyloric orifice of the stomach. By the alternate contractions of its longitudinal and circular fibres, the food is driven through its cavity along the great curvature from left to right towards the pyloric orifice, and back again towards the cardiac from right to left, and gradually becomes chyme. Of course it will be remembered that whenever the stomach becomes tolerably full, its inferior border is tilted forward, because there is no other way in which the organ could obtain sufficient space. The food requires from one to three minutes to make its circuit, and its current is the more rapid the nearer the end of the process. The pyloric end of the stomach is certainly most irritable, and contracts most strongly; but as digestion goes on, and the food becomes liquified, the pyloric sphincter gradually relaxes, and allows the passage at first only of the liquid, but afterwards even of solid food that is undigested.

Animal food is more digestible than vegetable; raw or soft boiled eggs and broiled venison may be stated as most so.

The food requires to be well triturated, else it will not be well digested; and the pleasure derived from the mastication of food has an excellent purpose in the advancement of digestion. The amount of gastric juice is regulated by the quantity of food; but in dyspepsia its quantity is often less than it should be. The action of the pepsine, in atoning for the want of sufficient temperature, is remarkable; as gastric juice will digest food, even out of the body, at 100°. The process of digestion is complete in two to five hours.

Vomiting may be caused in many ways, and is strictly reflex. A deep inspiration, closure of the glottis, and fixture of the diaphragm, are followed instantly by contraction of the posterior pillars of the palate and relaxation of the cardiac and pyloric sphincters; reversed contraction of the intestine, stomach, œsophagus, and constrictors of the pharynx, and especially forcible action of the abdominal muscles then take place. Some people, however, have a trick of regurgitating their food like ruminant animals; and this power may be acquired by practice.

The food as it enters the duodenum soon mixes with the biliary pancreatic and Brünnerian fluids, and is then called chyle, although that name ought to be reserved for the perfectly nutritious part of the food. The chyle in the duodenum has a milky appearance; and when allowed to stand in a tall vessel, separates into a cream which rises to the top, a clear part in the middle, and a dark sedimentary matter which is excrementitious.

Movements of the Intestines.—They are called peristaltic or vermicular, and are caused by the alternate contraction and relaxation of the fibres. The longitudinal first contract, and then a wave of contraction seems to pass along the circular fibres.

The valvulæ conniventes delay the transit of the nourishing fluid, and are covered with villi; but as these villi become fewer towards the lower part of the ileum, so the glands of Peyer are better and better developed. The residual matter assumes more an excrementitious character, and in the cœcum it becomes quite so. The bile i said to act as a natural purgative, and is said t cause the dark colour of fœcal matter; but thi is still uncertain.

A healthy man requires 5½ lbs. of solid and liquid food in a day, and about the same amount is lost by the various excretions. The amount of fœcal matter is 5½ oz., urine 42 oz., cutaneous transpiration 16 oz., carbon from lungs 10 oz., and the vapour from the lungs the remainder of 88 oz. A fasting man loses 5½ lbs. daily. Life may be sustained without food for 18 to 23 days, if water be allowed.

Sulphuretted hydrogen and other gases are developed in the great intestine, and its secretion is acid. This is formed chiefly in the cœcum, and its acidity may perhaps be due to lactic acid. The stomach and small intestines are always partially distended with gas.

The intestinal canal is longest in ruminants, shortest in carnivora, and of medium length in man.

The digestive organs in the animal kingdom are, 1st, A simple digestive cavity, with one aperture; 2d, The same, with several mouths; 3d, The alimentary cavity becomes distinct from parietes of body; 4th, Teeth are added; 5th, It becon tubular, and a mouth and arms are acquired; 6t It is divided into parts—pharynx, stomach, inte tines; 7th, Glands are added; 8th, Varieties i form, with ramification of canal, appear. In the cow or sheep the food enters the venter magnus, and after being reconsidered, passes back again to the reticulum, from that to the omasum, and then into the abomasum. The last cavity is the true stomach in ruminants; and it is by digesting its mucous membrane in dilute hydrochloric or acetic acid that artificial gastric juice may be procured.

STRUCTURE of INTESTINAL CANAL.—The mucous membrane in the mouth, œsophagus, and small intestines, is elevated into small papillæ, which are in reality identical in structure, with this exception, that the villi have very distinct lacteal vessels, the papillæ of the tongue being more largely supplied with nerves; yet they are both projections of the mucous membrane towards the cavity of the intestinal canal. On the tongue, indeed, they serve the functions of taste and touch, while in the small intestine they are chiefly for the absorption of food; but all of them are capable of absorbing rapidly, and none of them appear to produce secretion. On the contrary, all sacculations of the mucous membrane, whether they be the simple follicles of Lieberkühn, or the same follicles aggregated into gastric glands, or, like the glands of Brünner, consist of minute lobules, not distinguishable from salivary glands, have only the power of throwing off a secretion, but none of absorbing.

The papillæ of the tongue are elevated projections of the mucous membrane, in which the capillary and nervous distribution is very profuse. Understanding this, it will be easy to remember, that those which are shaped like inverted cones, and placed in little saucer-like depressions in the mucous membrane, are called Circumvallatæ; that those having the appearance of mushrooms, are called Fungiform; and those again which are conical or cylindrical, and very delicate, are called Simple. The circumvallate, or large papillæ, 8 to 15 in number, form two converging rows at the back part of the tongue, which meet in an angle behind the foramen cœcum. The fungiform are very red, and lie over the middle and anterior part of the dorsal surface, and are very numerous near the tip of the tongue. The simple papillæ occupy the same situations, and are closely set along the borders. There are also still finer papillæ which occupy the interstices, and are found upon the fungiform and circumvallate.

Simple and compound follicles are freely distributed over the tongue, and a few which are more complex, and resemble those of the pharynx and œsophagus, pour their secretion into the foramen cœcum.

The importance of the tongue as a means of diagnosis must not be forgotten. If its compound glands and simple follicles pour out a vitiated secretion, the alimentary canal in general is vitiated also. If its margins and tip are red, then inflammation may be suspected in the stomach or intestines. Indeed, the manifestations of internal disease observed at mucous outlets, are not confined to the intestinal canal, but exist equally in the genito-urinary. The pain at the point of the penis, from cystic or renal affections, is too well known to require comment.

The gastric glands are scattered over the entire mucous membrane of the stomach, but are collected in greatest number towards the pyloric extremity. They are called Alveoli, and are merely shallow six-sided depressions into which a number of the tubular follicles open.

Their diameter is 1·100th of an inch or more, and the little tubes that open into them are quite identical with those occupying the general surface: their length is 1·60th to 1·20th of an inch, and their diameter 1·600th.

Lenticular follicles with depressed centres are also found near the pyloric extremity, and along the great curvature.

If the mucous membrane of the stomach be divided by an incision at right angles to its surface, the cut edge will appear to be made up almost entirely of vertical tubes set closely side by side, with their closed extremities resting on the submucous tissue.

Now the villi commence a little below the middle of the duodenum, and are strictly limited to the small intestine, covering even the upper surface of the ileo-cœcal valve, but not its under surface. They are, however, much fewer in the ileum than in the jejunum. Their length is on an average 1·40th of an inch; and in addition to the ordinary structure of the mucous membrane, there is a very delicate muscular layer lying under the basement membrane. They contain a small artery and vein, a lacteal absorbent, and a number of free granules within the projecting extremity. It is quite certain that these granules become remarkably swollen during absorption ; but whether they absorb the fluid they contain through both the basement membrane and the epithelial covering, is a much more doubtful matter ; for it is not certain that the epithelium is cast off at every digestive period—if it is, then no circumstances could be more favourable to the rapid absorption of chyle. Although the manner in which the chyle enters the lacteals is not known, yet it must be either by rupture of, or transudation from the distended granules. But some think that the small bloodvessels within the villi secrete the chyle into the lacteal vessels. The persistent nuclei in the basement membrane, which are called centres of nutrition by Goodsir, reproduce the epithelium with great rapidity. When the lacteals are joined into larger ducts, they are observed to have a circular and a longitudinal fibrous coat, lined by a delicate epithelial layer. As they enter the mesenteric glands, they are deprived of their fibrous coat; and by their subdivision, convolution, and sacculation, they form the principal part of these organs, which also contain a number of corpuscles, and a copious capillary net-work. By re-union of the subdivided vessels, the emergent ducts are formed, and the fibrous layer, which became continuous with the investment of the gland, is now continued upon the emergent vessels. The motion of the small intestine greatly facilitates the transmission of the chyle, and the contraction of the fibrous coat also assists. Whether or not the vis a tergo of absorption acts with any considerable force, it is difficult to say.

The absorbent system is in a great measure characterised by the contractility of its vessels, and by the liberal supply of valves which they possess.

Brunner's glands are scattered over the whole surface of the duodenum, but are collected chiefly near its commencement. The valvulæ conniventes commence high up in the duodenum, but begin to lose their depth about the middle of the jejunum; and about the middle of the ileum they can scarcely be recognised. They are crescentic folds of the mucous membrane only, and are placed transversely, or nearly so, with respect to the long axis of the intestine, following one another closely. Each one extends two-thirds around the canal, and is about two inches in length. The villi found on them have of course the very same structure as those lying in the spaces between them.

The patches of Peyer, which are generally half an inch wide and from an inch to two inches long, appear to be composed of vesicles which are identical with the solitary glands. But the patches are found only on that part of the intestine which is opposite to the attachment of the mesentery; whereas the solitary lie around the entire canal, and have villi even on their surfaces. The vesicles are rather flattened, and contain a whitish fluid; but sometimes they are empty, and then an aperture may be seen in them. They are about the size of a millet seed, and each one appears to project from the floor of a saucer-shaped cavity: those in the patches are surrounded by a ring of minute openings of the follicles of Lieberkühn, but the openings are less regular around the solitary vesicles.

The glands of Lieberkühn are quite identical in shape with the tubes of the stomach, but are not nearly so long. They are copiously distributed over the entire intestinal surface, from the pylorus to the internal sphincter, but are more plentiful in the colon than in the small intestine.

The Solitary follicles of the great intestines are most numerous in the cœcum and Vermiform appendix. Their average diameter is 1·30th of an inch.

The œsophagus, like the small and great intestine, has longitudinal fibres externally, and a circular layer within these; but it is remarkable that its upper half is furnished with striated muscular fibres. These are said also to exist throughout its whole extent; but however this may be, it is only in its lower part that the peculiar rhythmic contraction, so characteristic of non-voluntary fibres, occurs. The pharynx, from its position, cannot collapse; but the œsophagus is flattened from before backwards, when food is not passing, and its mucous membrane, like that of the stomach, is to a certain degree thrown into rugæ. This is remarkably seen at the cardiac orifice of the stomach. The longitudinal fibres of the stomach are situated chiefly at the curvatures, the circular for the most part near the pyloric orifice, the oblique at the great curvature constituting the cardiac sphincter. On the cœcum, and also over the whole great intestine, except the rectum, the longitudinal fibres are collected into three bands that sacculate the organ. But on the rectum they are spread out, forming a very thick longitudinal coat.

Mechanism of Respiration.—The muscles of ordinary easy inspiration are the scaleni, the levatores costarum, the diaphragm, and intercostals; but easy expiration is performed by the resilience of the walls of the chest, and of the displaced abdominal viscera. Forced inspiration is performed by all muscles that can be made to take fixed origin above, and are inserted into ribs below; and forced expiration by the abdominal and other muscles that depress the ribs.

There are sixteen to eighteen respirations in a minute; that is, one for every four or five beats of the heart. Twenty cubic inches of atmospheric air are taken into the lungs at an ordinary inspiration, and one-third of the oxygen in the inspired air is replaced by carbonic acid gas. The amount of air that can be expelled from the lungs by forced expiration, performed after forced inspiration, is called the vital capacity of the lungs.

If the same air be repeatedly breathed, one-third of the oxygen will still remain, and it is only by breathing air in a confined space, with lime water to absorb the carbonic acid, that the entire amount of contained oxygen can be extracted. The air is renewed down to the air-cells at each respiration.

It matters not what is the cause, if the air is hindered from entering the lung, death is the speedy result. The blood enters the lungs for the specific purpose of becoming aerated by contact with oxygen ; and if it does not effect this purpose it remains in these organs : for there is no use of blood being circulated when it cannot benefit the system. When the trachea is tied in an animal, there are first of all violent voluntary efforts at inspiration, then these cease ; violent non-voluntary efforts then follow, but presently they also cease ; circulation which has gradually been becoming slower, stops altogether—first at the lungs, then in the system. The right side of the heart, and the entire pulmonary tissue, are found gorged with dark blood. But some poisons, such as aconite and hemlock, act by paralysing the voluntary muscles ; and as the muscles of respiration are at last affected, air no longer enters the lungs. These muscles may be paralysed in another way, namely, by the brain becoming insensible to the stimulus of the incident nerves of respiration. Strychnia, by causing spasm of the thoracic, as well as of other muscles, destroys life just as rapidly as any of the agents already mentioned.

The breath may be held for half a minute, or a minute, but the "besoin de respirer" soon becomes too intense to be borne.

For the performance of a function so essentially vital as respiration, every provision has been made. Almost all sensory nerves over the entire surface of the body may act as incident nerves of respiration. Every sudden irritation applied to the surface seems to cause inspiration; and respiration is constantly the result of a reflex action, of which the delicate terminal twigs of the pneumogastric are the exciters; the irritation being the stimulus of the venous blood in the capillaries surrounding the pulmonary air-cells.

Moreover, the open state of the glottis during inspiration, permits the free entrance of air, and the cartilaginous rings provide for its constant transmission. In cases of pure asthma, the very small bronchial tubes are in a state of spasm. The more rapidly the blood is sent through the lung, the more frequent are the respirations. This is obvious in women, and more so in children; but a diminution of the acting surface of the lung will also cause rapid respiration, even 50 in the minute, as in pneumonia. Dyspnœa, therefore, clearly indicates either rapidity of the circulating blood or imperfect supply of atmospheric air.

By forced inspiration, the chest may contain 250 to 400 cubic inches of air; but in its ordinary state

150 is the usual quantity. Even by forced expiration, 50 still remain, and after death there are 100.

As the air passes through the air-tubes, it causes "bronchial respiration," and by its distending the air-cells, the inspiratory murmur is produced. As the air recedes from the cells, a more delicate expiratory murmur may be heard. Bronchophony is produced by the reverberation of the voice in the bronchial tubes. Bronchial respiration, and bronchophony being, of course, perfectly healthy sounds, are produced in every part of the chest. But as the light and badly conducting air-cells are placed between the tubes and the surface of the chest, these sounds above mentioned can only be heard where the tubes are nearest the surface, namely, on each side of the first bone of the sternum, in each axilla, and between the scapulæ behind. In order that bronchial respiration and bronchophony may be heard over any part of the surface, it is only necessary that the vesicular structure of the lung shall be solidified between the surface of the chest and a bronchial tube, along which air is in motion towards a portion of lung, as yet open for the reception of air. But as bronchophony is merely the reverberation of the voice in bronchial tubes, its development does not even require that the tube in which it is produced shall communicate with open lung.

The peculiar modification of the voice called œgophony, is merely weak bronchophony, modified by its transmission through a thin layer of fluid contained in the pleural cavity.

In regard to percussion in disease, it must be obvious that whatever will diminish the amount of solid or fluid matter within the thoracic cavity, will also increase the amount of resonance on percussion; but whatever disease causes an increase of substance in the chest, will also diminish resonance on percussion. Percussion over a mass of tubercle, or hepatization, or an accumulation of fluid in the pleural cavity, will amply illustrate the observation, that chest disease is to be made out more by common judgment than by any abstruse diagnosis.

It must be remembered that the lung is a highly elastic and contractile organ, and that when the chest is expanded by the muscles of inspiration, the lung *follows* the expanding chest, because there is no communication between the pleural cavity and the atmosphere; and when the chest relaxes, the lung undergoes a corresponding contraction. It is only necessary to admit air into the pleural cavity, by an opening either in the wall of the chest or in the lung itself, and the immediate collapse of the lung will sufficiently testify to the truth of this statement. But if the elasticity of the lungs is impaired, either by the deposit of tubercle in its submucous tissue, or by the results of chronic bronchitis, the expiratory murmur which is caused by the resilience of the air cells pushing out the air, will of course be lengthened.

Although within the limits of health, the respiratory murmurs may differ a good deal in different persons ; yet, on listening at the chest, the inspiratory murmur is generally at least twice as long as the expiratory, and much louder.

As the pleura pulmonalis and costalis are constantly rubbing against one another, it is evident that if they move less glibly by their surfaces being roughened by lymph, they will also move more noisily, and produce a friction sound, which will be rather of a jerking kind, from the pain that almost always attends such exudation. If a little thick mucus happens to be stuck to the side of the larger air tubes, or if the smaller ones are roughened and their membrane thickened, then of course a wheezing or snoring sound may for certain be heard. But if there is fluid in the tubes or cells of the lungs, then a very different sort of sound may be expected: in all cases like what it really is, namely, the bursting of air bubbles in a fluid. The sound is called a *moist rale*, and is the finer the smaller the cavity in which it is produced; and of course the pneumonic rale ought to be and is the finest—its seat being the air cells. All unhealthy sounds that are not like the bursting of air bubbles in a fluid, are dry rales, in whatever way they are produced.

In Batrachian reptiles the lungs are simple membranous sacs. In serpents they are sacculated at the upper part. In birds the sacculations extend into the bones, and are continuous by tubes placed at one side of the joints.

The swimming bladder in fish represents a rudimentary lung, and their gills are merely external lungs.

MECHANISM OF CIRCULATION.—Circulation has for its object the transmission of healthy blood to every part of the body, and the proofs of its existence are derived from the continuity of the vessels in relation to the heart's cavities;

from the valves in veins, arteries, and heart; from the ligature or section of great vessels; from transfusion in the living, and injection in the dead body; and from microscopic observations in living animals. The heart is the central organ of the circulation, and the contractile power of its left ventricle, is quite sufficient to propel the blood throughout the system. The exact force of the left ventricle is uncertain, but the blood in the aorta moves with a force of four pounds four ounces. The rush of blood from the heart is of course intermitting, but the elasticity of the large arteries renders the current perfectly continuous.

The structure of the heart is muscular, and among its fibres are found small ganglionic bodies called Ganglions of Remack. Therefore it is thought by some to be an independent nervous centre. The auricles are composed of two layers of fibres, the inner of which are radiating, and on the right side extend up on the superior cava, the external layer surrounding both auricles. The ventricles consist of three layers,—the external layer consists of spiral fibres surrounding both ventricles, running from right to left, and from base to apex; the middle layer surrounding each ventricle separately, but extending rather from apex to base; the inner layer forming the columnæ carneæ, or musculi papillares, giving attachment to the chordæ tendineæ.

The motions of the heart are contraction and relaxation: contraction is active, but relaxation is passive. The contraction of the heart is called its *systole*—its relaxation its *diastole*. The first, or dull sound, accompanies the systole; the second, or sharp sound, occurs with the diastole The first sound is caused by the bruit musculaire of the contraction of the ventricles, the rush of the blood through the heart, the stroke of the apex of the heart against the side of the chest, and the smart flapping back of the mitral and tricuspid valves. The peculiar spiral arrangement of its muscular fibres causes the apex of the heart to be tilted up as the ventricles contract; but in addition to this, the whole heart is advanced in the cavity of the chest, from the effort made by the pulmonary artery and the aorta to straighten themselves out as the blood is driven into them, and so the impulse against the side of the chest is explained. The second sound of the heart is produced by the smart click of the semi-lunar valves, as the aorta drives the blood back upon them. From an ounce and a-half to three ounces of blood are propelled into the aorta by every contraction of the left ventricle, and this quantity of blood occupies about three inches of the aortic arch, and moves at the rate of three inches in a second. The sound produced by the contraction of the auricles is not heard outside the chest, and therefore does not at all assist in producing any of the cardiac sounds.

Of the time taken up by the sounds and pause of the heart, one half is occupied by the first sound, one quarter by the second, and the remaining quarter by the pause. The arterial pulse is the impulse of the heart's contraction, communicated along the blood in an artery, and felt by the finger applied over that artery.

As the heart must never cease, and as a period of rest is absolutely required for the perfection of all muscular action, it is evident that the relaxation of the heart is quite passive, and is in fact its period of sleep. Even rough irritation applied to its outer surface produces but little effect; but the stimulus of the arterial blood on its inner surface immediately excites it to contraction. The auricles contract first, and their contraction is instantly followed by closure of the ventricles. The attachment of the chordæ tendineæ is of the greatest consequence, as by the contraction of the columnæ carneæ to which they are attached, the edge of the valve is so pulled down, that the blood gets behind it and shuts it closely. When the heart ceases to contract, it does so, either because the blood does not enter it in sufficient quantity, or because it is not able to contract on the blood that distends it. In this last case, of course, there is syncope, but it is called asthænic; while syncope from deficient supply is called anæmic. In either case there may be death. Whenever the valves of the heart become incompetent, regurgitation at some of the orifices at least is the unavoidable result, and is accompanied by a lengthening of the first or second sound, or of both. The lengthened sound has a blowing character, but often presents curious modifications: sometimes, indeed, there are sounds produced by the heart for which no explanation can be afforded. The results of regurgitation may be very serious, and are only to be well understood by thinking over the ordinary course of the blood, and then considering what ought to result from obstructions to that course. Mitral valve disease will be found to cause dilatation and hypertrophy of all the cavities of the heart except the left ventricle;

while aortic semilunar valve disease will affect the left ventricle also.

The continual movement of the heart within its pericardium is performed softly enough in health, because the membrane is so smooth; but whenever the serous surface becomes roughened by lymph, a friction-sound is sure to be developed: unless, indeed, the serous surfaces have either adhered or been considerably separated by increased effusion.

Fœtal Circulation.—The blood which has been aerated in the placenta is returned by the umbilical vein which enters the umbilicus of the fœtus, and runs along the under surface of the liver as far as its transverse fissure. It there gives off a branch to the right and another to the left lobe, and continues backwards to the inferior cava under the new name of *ductus venosus.* The blood ascends in the inferior vena cava along with that which has been returned from the lower extremities, and from the liver by the hepatic veins, and enters the lower and back part of the right auricle of the heart. From this, guided by the eustachian valve and tubercle of Lower, it passes through the foramen ovale into the left auricle. From the left auricle it is driven into the left ventricle, and from the latter along the arch of the aorta to be distributed in part to the head and upper extremities. From these it returns by the superior cava to the upper and front part of the right auricle; but this current descends in front of the other, straight into the right ventricle. From the right ventricle it passes along the pulmonary artery, but gives a very trifling supply to the lungs, and passing through the *ductus arteriosus* it mixes with the remainder of the blood in the arch of the aorta, and descends in the usual manner to the lower extremities; but by far the greatest part is returned to the placenta by the umbilical arteries.

Changes in Circulation at Birth. At the first inspiration the blood rushes into the lungs, and the ductus arteriosus contracts and closes. The blood returning from the lungs into the left auricle, opposes the current from the right auricle, and a muscular septum which is already prepared completely closes the foramen ovale. It is either the imperfect closure of this aperture, or the persistent communication between the two ventricles that permits the mixture of the blood observed in morbus ceruleus. The umbilical cord being tiéd, the vessels that compose it shrivel up and become obliterated. The most remarkable facts in regard to the supply of the fœtus are—1st, Communication of the inferior cava with a nutrient and aerating organ situated exterior to the fœtus. 2d, The passage of arterial blood along the venous canal of the inferior cava. 3d, The communication between the two auricles. 4th, The connection between the pulmonary artery and the aorta.

In the adult circulation the blood is returned from the whole system into the right auricle. From this it passes into the right ventricle, and from this again to the lungs. From these it returns to the left auricle,—is poured into the left ventricle, and again distributed to the system. But it is especially worthy of remark, that neither the lungs nor the other parts of the system are preserved from congestion by valves at their orifices; whereas the heart, by means of its coronary valve, is sufficiently preserved safe from congestion, which might seriously impede its functions.

The whole blood of the system completes its circuit in about one minute; and although the rate of the current at the capillaries is not faster than an inch in a minute, the extent of these vessels (not more than 1·30th of an inch), is too small to delay the circuit in any material degree.

The portal circulation is characterised by the distribution of a vein in the manner of an artery. The blood from the stomach, the small and the great intestine, the pancreas and spleen, is collected by the portal vein which is formed behind the head of the pancreas by the junction of the splenic and superior mesenteric. This blood is then ramified to the minute structure of the liver, receiving first the terminal branches of the hepatic artery.

CIRCULATION IN THE LOWER ANIMALS.—In sponges there is merely transudation from cell to cell. In polyps the tubes that circulate nutritious matter communicate with the stomach. In compound polyps the tubes are separated from the digestive cavity, and cilia propel the fluid through them. But in echinodermata, and all higher, the fluid is propelled by contraction of the containing vessel. The invertebrata have only a sanguiferous system. The vertebrata have both a sanguiferous and an absorbent system. In mollusca a single propelling cavity is found. Fish have one auricle and one ventricle. Reptiles have two auricles and one ventricle.

In many articulata the circulation is very slow, because the perfect aeration even of the internal organs by the air that permeates the body renders greater rapidity unnecessary. In the Mollusca, however, the current is more rapid. In fishes and reptiles, but more especially in the naked reptiles, such as the proteus, siren, and frog, none of which have a large amount of corpuscles, the circulation is by no means rapid; and it is remarkable, that as the colouring matter of the blood increases, so do the rapidity of the circulation and the accompanying respirations, as is well exemplified in birds. The great rapidity of the circulation in the fœtus and infant (110 to 120) is no doubt connected with the exceeding rapidity of growth. And although in the fully developed state the pulse is generally about 80 in women and 70 in men, this difference may perhaps result from some peculiar causes of excitement affecting the one sex more than the other.

During the winter sleep of certain animals (hybernation), circulation and respiration become exceedingly slow, and digestion is much diminished; and whether this state be partial, as in the bear, the badger, and the raccoon; or more perfect, as in the bat, the hedgehog, the dormouse, and the marmot; or complete, as in frogs, serpents, and lizards, kept in artificial cold, during the continuance of this state life is by no means easily destroyed.

Lymphatic hearts exist chiefly in the naked reptiles, and appear to be influenced by the spinal cord, but probably not to a much greater degree than the sanguiferous heart. They are placed at the entrance of lymphatics into the great veins for the purpose of driving the lymphatic fluid among the blood. In the frog they are four in number.

SECRETION consists in cell development taking place on the free surface of a basement membrane at the expense of the blood distributed in the vessels that ramify on its attached surface — it is, in fact, nutrition of a peculiar kind, depending upon the selecting power possessed by the nuclei of the gland cells. A considerable amount of the vatery part of most secretions no doubt passes hrough the membrane by direct transudation, in ie same way as much watery or other perfectly iid matter is absorbed directly by capillary blood-ssels during digestion, as well as under other umstances.

ecretion has for its object the separation of e kinds of fluids from the blood; *first*, those h are poisonous in their nature, and are to st entirely out of the body; *second*, those by which the food is prepared for conversion into blood; and *third*, those which fulfil a peculiar function after they have passed out of the body. The urine, sweat, a large part at least of the mucus, and all the secretion of the lungs, belong to the first class. Those already mentioned as assisting in digestion are comprehended under the second class. The milk and the semen, perhaps also the secretion of the prostate and Cowper's glands, constitute the third class.

Mucus indeed ought never to be considered as altogether excrementitious; but that of the genito-urinary and air passages does not appear to perform any other function than that of lubricating and protecting the surfaces upon which it is poured out.

Although the term *blood-gland* has been applied to the spleen, the supra-renal capsule, the thymus and thyroid bodies, yet they have no better right to that name than the mesenteric or other absorbent glands. The name, no doubt, may be proper enough when it is considered that such bodies may very probably exert some important function in the development of the blood, chyle, and lymph; but then there is in reality nothing for certain known in regard to the action of the spleen and other similar organs. All that is known about the function of the spleen has been derived either from the examination of the body after death, or from some experiments prosecuted under circumstances that rendered their results very unsatisfactory.

The term *conglobate* is often applied to absorbent glands, *conglomerate* being generally used for secreting glands; but all such names serve to throw indistinctness over a subject which has in reality no difficulty attached to it.

A gland then, is merely a sacculation of mucous membrane or of the skin, which is, after all, merely a continuation of it different in appearance, no doubt, because covered with a thicker epithelium for purposes of protection. True glands, therefore, open either upon a cutaneous or mucous surface. The mammary, the perspiratory, the ceruminous, and the sebaceous, open on the cutaneous; all other glands whatever open on the mucous surface.

Now, as has been formerly stated, all glands are either tubular or saccular; and of these two forms the saccular is the more plentiful. The simple follicles of Lieberkühn are the simplest examples of the tubular gland. The tubes in the stomach, although longer, are also quite straight, and it is only near the pyloric orifice that their cæcal extremities become at all sacculated. The ceruminous glands, however, are convoluted tubes, though not convoluted to the same degree that the sweat glands are. In the testicle, and still better in the kidney, we observe the highest development of tubular structure in glands.

Glands consisting of a simple vesicular pouch, nearly globular in form, are very numerous in the trachea and bronchial tubes. Physiologists, according to their own fancy, give various names to glandular structure; for example, these have been called *lenticular*, although lenses differ very much in shape. Some simple follicles have a sacculated appearance, and these *multilocular crypts*, as they are called, exist in the tongue and elsewhere. Several vesicular saccules, clustered round and opening into a minute duct, constitute the simplest form of a compound follicular gland; and it is of clusters such as these that the Brunnerian, the salivary, the pancreatic, the mammary, the prostate glands, &c. are composed. Certainly there are differences among these, not only in regard to the length of the excretory ducts, but also with respect to the forms of the vesicles themselves: some are flatter than others, and it is especially from the remarkably globular appearance observed in the vesicles of the salivary and pancreatic glands that these have received the name of *racemose*—they are truly like a bunch of currants.

If the system has been accustomed to furnish any particular secretion in large quantity, the stoppage of it is always attended with great danger.

The sudden invasion of dropsy, sometimes attended by convulsions and coma, which often takes place after obstruction of the secretion of the kidneys and skin, so frequent during recovery from scarlet fever, sufficiently demonstrates this fact. In this case the urea is generally supposed to produce the poisonous effects. The secretion of the lungs, however, must be thrown off, for its detention in the blood would be immediately fatal. The amount of carbonic acid thrown off by the lungs may be diminished without a fatal result, but then it must be by some other organ acting vicariously with the lungs. The uterus is thought by some to assist the lungs in throwing off carbon from the system in the menstrual blood. The secretion of bile may be stopped without life eing destroyed, as may frequently be seen in

jaundice ; but the term stoppage here refers
to the fact that no bile comes through the d
and it does not mean that the bile has not b
secreted ; for the most certainly fatal cases
supposed to be those in which the secretion h
not been produced at all—the less dangerous on
being those where the secretion has been rea
sorbed.

The influence of the mind upon the functi
of secretion is very remarkable, and may be illu
trated by the vitiation of the mammary secreti
from mental causes. It is scarcely credible th
the mind can have any influence upon the gla
cells, and it seems more likely that the capilla
vessels are affected. It may be suggested as po
sible, that in this case the secretion of the live
or of the kidney—perhaps of both—having bee
suppressed from spasm of their capillaries, t
mamma, by attempting to atone for the suspend
action of these organs, may have added to t
milk an amount of poisonous matter sufficient
destroy the child.

Secretion, however, may be prevented in
totally different manner, and in one deserving
the highest attention, namely, by fatty degener
tion of the glands. This may occur perhaps in

glands except the lungs, in which it would be a matter of extreme difficulty for fat to collect.

Fatty degeneration may be defined as the deposition of oil granules in the secreting cells of a gland, to the injury if not destruction of its function. When by rupture of the cells the organ has become infiltrated with fat, then the term *waxy degeneration* is applied to it. Chronic Bright's disease and fatty liver are excellent examples of these changes in glands.

In conclusion, it may be stated, that the vicarious action of glands is one of the most important, as well as one of the wisest provisions of nature, from which the physician may constantly derive most valuable lessons in the diagnosis and treatment of disease.

II. INNERVATION.—As the very lowest animals contract when they are touched, appear to feel the presence of surrounding objects, and avoid obstructions to their progress, it is fair to infer that they possess both sensation and voluntary motion; and as their substance is often perfectly homogeneous, this is just another proof of the imperfect state of our knowledge in regard to the sort of structure necessary for exhibiting contractility and sensibility.

There are two distinct nervous systems in man, —namely, the sympathetic, which rules over non-voluntary, and the cerebro-spinal, which regulates voluntary muscular movements. The cerebro-spinal, like every other nervous system, consists of a central part—the brain and spinal cord—for the origination, transmission, and reflexion of stimuli; and of a peripheral part—the sensory and motor nerves—for conveying all impressions to and from the nervous centre, and so connecting the mind with the external world.

Again it must be remembered, that nervous fibres cannot originate the slightest nervous force, any more than the wires of an electric telegraph can the electric current. Yet nervous fibres differ in their properties, although not in external appearance.

The fibres of the nerves of special sense conduct only the sensation they were created to appreciate; but common sensory fibres are excited only by common irritants. These too, moreover, convey impressions only towards the nervous centre. Motor fibres, on the other hand, are only of one kind, and never convey impressions that are made upon them in any other direction than towards a tissue that is endowed with contractile power.

The **Brain** consists of four distinct masses,—the cerebrum, the cerebellum, pons varolii, and medulla oblongata. But the purely cerebral functions appear to exist only in that part of the cerebrum lying above the level of the corpus callosum.

The **Cerebral Functions** are sensation, volition, and consciousness; thought, memory, and judgment; with the power of originating ideas; which last is peculiar to the human mind.

The grey matter is accumulated principally on the surface of the cerebrum over the convolutions; but it is also collected in the corpora striata, optic thalami, &c. in the interior of the cerebrum. Now, although the intellectual faculties are supposed to reside in the peripheral grey matter, while sensation and volition are thought to be associated with the central cerebral matter, it is quite certain that a very considerable portion of the grey and white matter at the outer part of the brain may be entirely removed, and yet all the cerebral functions remain quite perfect. Therefore it is not possible to say what portion of grey matter can perform any one function whatever. Even in cases where the white matter on one side has been almost entirely converted into a creamy-like substance, all the functions of the individual have remained perfect during life.

In the lower animals, when one hemisphere is sliced down as far as the corpus callosum, the sight, hearing, and smell of the opposite side are entirely lost; but when both hemispheres are removed, complete insensibility ensues. Where the corpus striatum has been cut across, the animal has run forward; and partly from this fact, partly because the anterior roots of the spinal nerves terminate in these bodies, the function of volition has been supposed to reside in them.

The optic thalamus has something to do with vision, and so have the corpora quadrigemina; and the cerebrum may be considered as the centre or reflex action for those nerves of special sense that can produce any muscular action.

The PONS VAROLII may have some sensibility, but its influence is known only by the negative information derived from its injury in the lower animals, in which such injury was followed by a general muscular paralysis, and death by asphyxia.

The crura cerebri, which may be also considered as centres of reflex action, extend from the pons varolii to the optic thalamus, and by cutting across either one crus or its corresponding thalamus, a most remarkable rotation around the vertical axis of the animal takes place, and seems to be connected with an irregularity of nervous supply from the two sides of the brain.

As the pons terminates on each side in the crura cerebelli, division of onecrus in any animal causes it immediately to fall upon its opposite side, and to rotate around its long axis towards the sound side. When both crura are cut, the motion is entirely lost.

The **CEREBELLUM** combines and regulates muscular movements; and when one hemisphere is destroyed, the result is the same as that of cutting the crura cerebelli; and if the entire cerebellum be removed, the animal cannot perform any combined movement whatever, such as flying or walking—cannot even stand.

The **MEDULLA OBLONGATA** is the centre of reflex action for deglutition and respiration; it is also a conductor to and from the brain, serving, in fact, as a constituent part of the spinal cord. The destruction of the medulla oblongata is perfectly equivalent to the entire destruction of life, for respiration is a vital function.

The Spinal Cord is not only a conductor of irritations towards the brain, and of stimuli from the brain, but is also an independent nervous centre. According to some, it consists of a chain of ganglia, so embedded among white matter and continuous with one another, as not to be clearly distinguishable. But as one isolated portion is capable of producing reflex action in the muscles whose nerves are connected with it, its ganglionic structure is highly probable. The spinal cord is the essential part of the nervous system in vertebrata. Its grey matter originates motor stimuli, which, by the volition of the brain and the regulating and combining influence of the cerebellum, are made to produce the most varied and intricate motions. Softening of the spinal cord, like that of the brain, may be pretty extensive without obvious symptoms; but as a general rule, applicable equally to the encephalon and to the cord, inflammation of the membranes is more liable to be marked by convulsive muscular actions than similar affection in the substance.

The only purely cerebral part of the brain lies above the corpus callosum, and meningitis of the hemispheres down to this level is attended with delirium and coma, while meningitis below this level will be accompanied by paralysis or convulsions.

Purely cerebral diseases are such as are attended either by derangement or suspension of the cerebral functions. In coma these are suspended, and may remain so for months, until the cause which produces the insensibility is removed. Inflammation of the brain, which in children is called Hydrocephalus, may either derange or suspend them. Insanity and delirium tremens, in its early stage, are examples of deranged functions.

Purely spinal diseases arise from derangement of the spinal cord. They are hysteria, chorea, tetanus, hydrophobia, and many other convulsive as well as paralytic affections.

The cerebro-spinal diseases are catalepsy and epilepsy.

Internal sensation is the consciousness of some change in grey matter for which no external cause can be found. The sense of languor or fatigue; of exhilaration or depression, of pain or pleasure; of nausea or sickness; as well as the feeling of muscular power; of hunger and thirst; of sexual desire; of heat and cold, and many others, are all included under this head.

External *sensation* is the consciousness of a change that has taken place in grey matter, by an impression conveyed to it along a sensory nerve; and *sensibility* is the power to become conscious of any such change. Therefore the medulla and spinal cord, in which there is no consciousness, cannot, in the true sense of the word, have sensibility; but by their nerve-cells, in common with those of the brain, they are capable of changing the direction of an irritation conveyed to them by nerve-fibres. And in this manner it is that reflex action may be produced. But the wonderful circumstance connected with reflex action is, that it always has the intent, if not the effect, either of preserving the body or of performing some function. As the mind gets wearied, the functions of the brain become dormant. But the spinal cord and medulla oblongata are ever on the watch for the preservation of the system. Even in a sleeping man the limb is drawn away when irritation is applied to it.

The sympathetic system consists of nervous centres called Ganglia, and of nerves that communicate with them. Each ganglion looks almost like a brain, for the nerves radiate from it, or come towards it in various directions; and each one certainly is capable of reflecting, if not of originating stimuli. This system influences the contraction of the non-voluntary muscular fibres from the middle of the œsophagus down to the external sphincter ani; and by the presence of food in this canal, all the reflex motions called Peristaltic, &c. are produced. It greatly influences the motion of the heart, and through it only do the contractions of the arterial and capillary systems take place. The fibres of the air-tubes, however, appear to be influenced by the pneumogastric nerve. The contractions of the bladder are influenced by the sympathetic to a great extent; and the uterus, which formerly was thought to be under the influence of the spinal cord, has been proved by Professor Simpson to contract after the spinal cord had been divided.

These statements in regard to the powers of the sympathetic system cannot be considered as perfectly clear. The cerebro-spinal system usually acts independently, and so does the sympathetic. But any powerful impression made upon either of these systems will seriously affect the functions of the other. Mental emotions, indeed will produce blushing; yet the mind is in the brain, and the ganglionic nerves govern the capillaries. Intestinal irritations will produce convulsions in children; yet again the mucous membrane is supplied by the sympathetic, and the voluntary muscles by the cerebro-spinal system. The truth is, that grey fibres, which are characteristic of the sympathetic, and white fibres, which are characteristic of the brain, do really both exist in every nerve throughout the whole system; only the former predominate in the sympathetic,—the latter in the cerebro-spinal nerves. A little consideration will make the matter clear enough, as far as it is capable of being understood.

CEREBRO-SPINAL REFLEX ACTIONS.—Whatever stimulus will so excite any part of the grey matter as to cause the transmission of motor influence independent of the will, is truly an exciter of reflex action. I make this statement lest it might be thought that reflex action can only result from irritation applied to the superficial distribution of a sensory nerve; for the feeling of nausea, or even the thought of disgusting things, will act as the exciters of reflex action. In fact, all muscular action that does not originate from the stimulus of the will must originate from some other cause, and of course must be reflex.

The natural action of deglutition, and the absolutely essential one of respiration, have been already considered. Contraction of the pupil from the stimulus of light on the optic nerve, sudden closure of the eyelids, sneezing from irritation on the nasal mucous membrane, spasm of the glottis from irritation, coughing from the same cause, laughing from tickling of the skin, suction of the new-born infant, and vomiting, are all to be referred to reflex action. And the easiest way to remember what are the incident and what the motor nerves engaged in the production of any reflex action, is to consider where the irritation originated, and where the muscular action was produced. For example, the act of respiration may be produced by the application of cold to any part of the surface; and whereas the fifth nerve alone supplies the conjunctiva and schniederian membrane, to it alone can be referred the incident power of exciting winking and sneezing.

Muscular motions in any part of the limbs or trunk of the body, under the influence of impressions made on the nerves of the skin, such as tickling, pricking, &c. and so also shuddering from cold or from grating noises, are to be considered under this head.

Reflex Actions depending on the Sympathetic System, are forced contraction of the sphincters of the anus, urinary bladder, and vagina, under the influence of local irritation, erection of the penis, and emission of semen, rhythmic action of the heart, peristaltic motions of the intestines, expulsive action of the urinary bladder, expulsion of the child from the uterus in parturition, contractions and dilatations of the bloodvessels in the production of blushing, flow of tears, bile, &c. In conclusion, it cannot be too strongly impressed, that whatever muscular movement does not acknowledge the will as its cause, is to all intents and purposes reflex, whether the individual be conscious of its occurrence or not. A man is perfectly conscious when he is breathing, swallowing, winking, &c.; and although he may influence these, he cannot hinder them. Of course he is quite unconscious of any movements that may occur during sleep.

Before it is possible to understand the effects of disease and injury upon the nervous centres, it is imperative that the ordinary conditions under which these organs exist should be clearly understood. Both the nerve cells and the nerve fibres of the brain are extremely delicate, and are therefore easily affected by pressure or injury. In health, the cranial cavity is completely filled with the brain and its membranes, and is understood to contain the same quantity of fluid always. Now, although fluid is incompressible, yet it certainly is affected by pressure; for each particle transmits to all particles that surround it the same pressure that is applied to itself; and, consequently, even slight increase of pressure may render the grey matter unfit for its function. The brain is well protected by the cranial bones; well nourished by the vertebral and carotid arteries; and gently and equably pressed upon by the cerebro-spinal fluid, which supports it like a water bed. Now, of all things, what affects the brain most powerfully is any *sudden* change in its circumstances. It may get on pretty well with very serious chronic disease, but acute disease cannot be borne. Even a perfectly healthy man will feel giddy if he rise up very suddenly from the recumbent posture; for by this change of position the supply of blood to the brain is diminished. In the same manner, sudden loss of blood causes faintness, for the brain is robbed of its supply. Sudden diminution of pressure, therefore, is quite sufficient to produce perfect insensibility, from which the patient will not recover unless the healthy pressure be quickly restored.

A concussion, if sufficiently powerful, will cause immediate insensibility; and from this condition, in many cases, the patient never recovers. If the irritability of the grey matter has not been entirely destroyed by the shock, then the patient may be roused.

In the state of compression, whether that be produced by extravasation of blood, by depressed fracture, by abscess, or any other cause, it is impossible for the patient to be roused as long as the depressing power is acting on the brain.

It appears to be established that the amount of blood within the brain is not subject to almost any degree of change, and therefore the effect of coughing, in causing convulsions or insensibility, must be explained upon the principle that even any attempt to force more blood into the brain will be followed by severe injury to its functions.

All the conditions that may produce insensibility are certainly not known. The state of sleep is quite unexplained, and so are many other peculiar conditions of the nervous system. But it must be remembered that an injury to the nervous system can never be estimated by itself, any more than the death of a king can be considered as a change affecting only one person.

STRUCTURE AND ARRANGEMENT OF THE NERVOUS CENTRES.—1*st*, *The Spinal Cord* extends from the upper border of the atlas to the lower border of the first lumbar vertebra. It is sixteen or seventeen inches long. If the medulla oblongata be considered as the highest enlargement of the cord, then the second one, widest from side to side, lies opposite the four lower cervical; and the lowest, which is thickest from before backwards,. lies opposite the last dorsal vertebra. As the cord occupied the whole canal before the fourth month of uterine life, a filamentous process of the pia mater still extends to the lower part of the spinal canal. As the cord, like the brain, and many other organs, was originally formed by two lateral portions; so the anterior and posterior fissures nearly separate the cord, and mark this original division. On the outer surface of each half there are two grooves, between which is the lateral column of the cord, possessed partly of motor, partly of sensory fibres; but the posterior column is of purely sensory, and the anterior column of purely moter fibres.

When the cord is cut across, its cut surface presents two crescent-shaped masses of grey matter, with their convexities towards each other, and connected by a transverse band, or commissure of grey matter, which has a delicate layer of white transverse fibres behind, and a thicker one in front. It may be here remarked, that whatever matter, whether grey or white, is divided, in making a perpendicular section from before backwards, of the spinal marrow or brain, exactly in the mesial line, is a commissure; for it is only in this way that the two lateral halves of the brain, or medulla, can combine their power, whether of mind or motion. The posterior or gelatinous part of each crescentic mass is pointed, and crops out at the posterior lateral groove. Its anterior or spongy extremity is rounded and directed towards the anterior lateral or motor groove, but does not appear at the surface. The gelatinous part has a great deal of granular matter, but few cells, and is traversed by delicate fibres, both gelatinous and white. The spongy contains many large caudate cells, also with granules and fibres. The white matter of the cord consists of delicate nerve-tubes, easily becoming varicose, and arranged both longitudinally and obliquely.

The posterior roots of the spinal nerves are always larger than the anterior, and always present a ganglionic enlargement, with which the anterior root never mixes. The two roots join immediately on the peripheral side of the ganglion, and the resulting compound nerve divides into two divisions, of which the anterior (except in the first, second, and two last spinal nerves) is always largest, because it has most structure to supply.

The pia mater covering the spinal cord differs from that investing the brain in its being more fibrous; but the dura mater and arachnoid membrane have the same structure as those of the brain. One peculiarity, however, in the arrangement of these membranes is deserving of especial notice, namely, that opposite to the lateral columns of the cord they are, as it were, glued together, and solidified into a single fibrous band, which being narrower between the anterior and posterior root of each pair, and wide between each pair, and the one below or above it, has a peculiar toothed appearance, that has given rise to its name of *ligamentum dentatum.* It obviously serves not only to keep the anterior and posterior roots of the spinal nerves separate from one another, but also slings the spinal cord so nicely in the subarachnoid fluid, as to prevent injurious or fatal effects from concussion. But besides this arrangement, the venous plexuses, nutrient arteries, and cellular tissue, lying behind and in front of the dura mater, and separating that structure from the spinal canal, assist greatly in preventing concussion.

The spinal nerves at the upper part of the cord arise nearly opposite where they pass out; but as the cord is shorter than the canal, the intervertebral foramena, where the nerves emerge, are further and further distant from the part of the spinal cord where they arise, and this is the reason why they are accumulated at its lower part to form the cauda equina. The ganglion, however, always lies exactly in the intervertebral foramen, except in the first two cervical, and last two sacral of the thirty-one pairs.

The arteries which supply the cord, its membranes and nerves, are given off by the vessels lying nearest; they are the anterior, posterior, and lateral spinal, by the vertebral; and lateral spinal, along the rest of the canal by the aortic intercostals, the lumbar, and the sacral arteries.

2d, *The medulla oblongata* extends from the spinal cord to the lower border of the pons varolii, and rests upon the basilar groove of the occipital bone, and upon the vertebral arteries as they ascend to form the basilar. It is nearly vertical in position, and the cerebellum rests against its posterior surface. There is, however, a little space existing between the upper and back part of the medulla, and a thin translucent lamina of white matter on the under surface of the cerebellum: this is the fourth ventricle.

The medulla is pyramidal in form, convex in front, and slightly concave behind. It is an inch and a quarter long, half an inch thick, and three-quarters of an inch broad at its widest part.

The pyramidal bodies lie on each side of the anterior fissure; the olivary project external to and behind them; then come the restiform or rope-shaped bodies; last of all the posterior pyramids lie on each side of the posterior fissure.

The reason why the descriptions of the medulla oblongata are usually so confusing, appears to be that the essential difference between it and the spinal cord is not sufficiently insisted upon. This difference especially consists in the recession from the surface of the lateral pyramid and the apparent substitution of the olivary body in its place. It follows upon this to enquire what becomes of the lateral column? In the first place, a large portion of it crosses to the opposite side of the medulla, pushes outwards the fibres of the anterior column, and, by this addition to their mass, constitutes with them the *pyramidal body*. In the next place, another portion composed of fibres, both superficial and deep, joins with all the posterior column except the slender fasciculi on each side of the mesial line, and constitutes with it the *restiform body;* and the posterior bundle which did not assist in forming the restiform body is continued up under the name of the *posterior pyramid.* The third part of the lateral column ascends into the floor of the fourth ventricle, and forms two round grey-coloured bundles which lie in the little triangular space left by the divergence of the posterior pyramids, and are marked by transverse striæ, which constitute the origin of the auditory nerve. The striæ were thought to resemble the *feather*, the round bundles, the *barrel;* and the angular space between the posterior pyramids the *point* of a pen, and therefore the striæ were called the *Lineæ transversæ* of the *Calamus Scriptorius.* The round bundles uniting with the posterior pyramids are continued into the upper stratum of the crus cerebri. The pyramidal bodies are slightly constricted as they enter the pons, and are continued on to the under part of the crus. The restiform turn back, and are continued into the cerebellum, of which they form the inferior peduncle.

The olivary body is an oval white mass, about six lines in length, and half imbedded in a mass of fibres derived from the outer part of the anterior column, the part, namely, which does not enter into the formation of the pyramidal bodies. In the olivary body there is a convoluted or indented capsule of grey matter containing white.

The pyramidal bodies decussate not so much with one another as with the opposite lateral columns, and the fasciculi that interlace for about a quarter of an inch along the anterior median fissure are very few, when compared with those in the substance of the medulla.

The pyramidal are the only bodies in the medulla which are entirely made up of fibres, and they appear to conduct motor stimuli alone.

3d, *Formation and Arrangement of the Cerebrum.* In the spinal cord the grey and the white matter are perfectly distinct from one another; but in the medulla oblongata they become mixed in such a manner that all regular arrangement is apparently broken up, and the grey matter, as before stated, appears in the floor of the fourth ventricle, namely, that part of the medulla which lies behind the pons varolii. As the fasciculi of the spinal cord traverse in succession the pons varolii, the optic thalamus, and the corpus striatum, they are greatly increased in size by the addition, not only of the grey, but also of the white matter, and so, in reality, all the parts of the brain are developed from the spinal cord by the enormous increase of grey and white matter. The crura cerebri consist of an upper stratum which extends through the optic thalamus and corpus striatum, and of a large lower part, extending entirely through the corpus striatum. The locus niger, which is so remarkable for its large caudate corpuscles, separates these two strata from one another. The grey matter of the cerebral convolutions follows exactly every bending of their surface. Some of the sulci are an inch or more in depth, and this peculiar folded arrangement of the grey matter tends to increase its volume very greatly within a very limited space.

In the upper classes of vertebrata, the amount of intellect seems always proportioned to the development of the grey matter; and from early age onwards, to the full maturation of the intellectual powers, the grey matter evidently increases.

The grey matter of the convolutions consists of about three layers, with white matter interposed, and is altogether rather more than an eighth of an inch thick. It consists principally of the middle sized nerve cells, with numbers of the smallest size, and much granular matter. The pia mater invests the cerebral convolutions, and the surface of the cerebellum in the closest possible way, following every bending, and entering every crevice of the surface. The vessels are ramified in its delicate cellular net-work, so small as two or three removes from a capillary before they enter the nervous substance.

The appearance called *centrum ovale minus*, which is produced by making a horizontal section of one cerebral hemisphere, not so low down as the corpus callosum, and the *centrum ovale majus*, produced by slicing down the brain to that level, consist merely of the white matter surrounded by the convoluted border of grey matter. The surface is all studded over with little points of blood from the cut vessels, and this sufficiently demonstrates the great vascularity even of white matter, although the grey, from the activity which it requires, has always the fullest supply.

The corpus callosum is the great commissure of the brain, and is fully four inches in length.

In front and behind it, as well as above it, the hemispheres can be separated. When the corpus callosum is cut through in front and behind, and lifted up, a triangular cavity is seen below it; those parts of the corpus striatum and optic thalamus, which are not embedded in the cerebral substance, project into this cavity, which is divided into two lateral portions by a perpendicular septum, called *Septum lucidum*, between the layers of which is a little interval called the fifth ventricle. There is really no ventricle at all, as soon as the corpus callosum is removed. The corpus striatum is the most anterior projection in the floor, as it is called, of the lateral ventricle. It is brownish-grey in colour, rather pear-shaped, and connected to the front and outer part of the optic thalamus by a little belt of white mater, called *tænia semicircularis*. The most part of the thalamus is concealed from view by the fornix and by the choroid plexus, which protrude on each side of it.

The fornix is another commissure of the cerebral lobes, and is the continuation forwards of the corpus callosum, after it has doubled upon itself at its posterior border. The fornix is triangular and arched; it descends and dips down in front to the base of the brain, where it ends in the *corpora albicantia*. When it is lifted up, the velum interpositum is seen to be continued across from one choroid plexus to the other, forming an extremely vascular net-work, and the two veins of Galen lie along its centre.

The choroid plexus on each side, which is merely the fringed border of the velum interpositum, passes down the descending cornu of the lateral ventricle, and reaches the base of the brain, and is continuous with the pia mater. The position occupied by the velum interpositum and choroid plexuses, is the transverse fissure of the brain, and extends from the fissure of Sylvius on one side, to the same fissure on the opposite side. The velum forms the roof of another space, called the third ventricle, which is merely the interval between the two optic thalami. Three commissures cross this ventricle, a round white one in front, an oval and large grey one in the middle, and another white one behind. The same parts that lie within the circle of Willis, in the base of the brain, form its floor. The junction of the two corpora striata bound it in front, and the channel leading into the fourth ventricle bounds it behind. In contact with the under surface of the velum, at its back part, is the pineal gland, which rests upon the nates of the corpora quadrigemina; and these last form part of the roof of the *iter a tertio ad quartum ventriculum.* There is a fillet of nervous matter extending from the testes to the cerebellum on each side of this channel, and this, which is called the *Processus a cerebello ad testes*, forms the lateral boundary of the fourth ventricle.

The purpose of the phosphate of lime within the pineal gland is quite unknown.

In regard to the difficulty of understanding the brain without actual dissection, of course it is insuperable; but great confusion may be avoided by keeping clearly in mind that anatomical expressions are very definite, and that a fissure does not necessarily mean a wide space, but may refer merely to the interval between adjoining masses which lie in contact, but do not amalgamate.

4th, The cerebellum is about one-seventh the weight of the cerebrum, and consists of two lateral lobes connected together by a middle one—the upper and lower surface of which are called the superior and inferior vermiform processes. Its surface is not marked by convolutions, but appears to be made up of plates of grey matter. When cut into, it is seen to consist of white matter surrounded by grey, which projects inward upon it, and causes the remarkable appearance called *arbor vitæ.* In the same manner as the brain looks like a tumour growing upon a stalk, the crus cerebri, which is therefore called its peduncle, so the cerebellum may be also considered as a mass developed upon three bundles of peduncular fibres; first, the restiform body constitutes its inferior peduncle, then the crura cerebelli, which are merely the lateral extensions of the pons varolii, form its middle, and the band of fibres coming from the testes constitutes the third or upper peduncle. The grey matter on the surface of the cerebellum contains caudate cells mixed with granular matter and clear nerve cells, which greatly resemble pus corpuscles. The deeper matter contains numbers of the smallest sized cells resembling nuclei. In the white substance of the cerebellum a ganglionic mass called Corpus rhomboideum is embedded.

5th, *The sympathetic ganglia* vary in number, but have always the same structure, like the grey matter of the brain and spinal cord; they consist of nerve cells, grey and white fibres, supplied with an intricate plexus of bloodvessels; but with this difference, that their corpuscles are generally large, have either a spheroidal or caudate form, and are surrounded by sheaths either of grey fibres or of tissue that greatly resembles them. The component parts of each ganglion are bound together by cellular tissue, and form a mass having a pinkish grey colour, and a pearly lustre. Each ganglion appears to resemble a brain, sending branches to the ganglion above and to the ganglion below; branches to join the anterior divisions of the spinal nerves and others that run forwards or outwards for distribution to the tissues.

The sympathetic system commences on the anterior communicating artery of the circle of Willis, and terminates at the ganglion impar upon the coccyx. The carotid plexus may be looked upon as the centre of the sympathetic for the cranium; the cardiac plexus as the centre for the thorax; the solar plexus as the centre for the abdomen, and the hypo-gastric plexus as that for the pelvis. The ciliary ganglion, which lies between the external rectus and the optic nerve; Meckel's ganglion, lying in the spheno-maxillary fossa, close to the spheno-palatine foramen; the otic ganglion, situated upon the middle meningeal artery; and finally, the submaxillary on the submaxillary gland, are all connected with the fifth nerve. The superior cervical ganglion, lying opposite the two upper cervical vertebræ, gives off the superficial cardiac; the thyroid ganglion, opposite the fifth cervical, gives off the middle cardiac; and the vertebral ganglion, lying on the root of the 7th transverse process, gives off the lower cardiac nerve; and these accumulate their power upon the bifurcation of the trachea, just behind the aortic arch. One ganglion lies on the head of each rib; and the inner branches of the first five communicate across the thoracic aorta, and assist in forming the pulmonary plexuses. Those of the second five form the great splanchnic, and those of the tenth and eleventh the lesser splanchnic. The great splanchnic lead to the semi-lunar ganglia, which are situated on each side of the cœliac axis; and these constitute the solar plexus, from which nervous plexuses radiate along the branches of the abdominal aorta which are not supplied by the renal plexus. The lesser splanchnic terminate in the renal plexus, which lies on and supplies the renal artery, and, with the aid of the solar plexus, also the spermatic. The abdominal aortic, the inferior mesenteric, hypogastric, and pelvic plexuses, are formed of the four or five lumbar, and three or four sacral ganglia. The sympathetic system is obviously very far different from the cerebro-spinal—at least in one respect, namely, that fresh deposits of grey vesicular matter take place on the course of its branches, and that the absolute number of fibres appears greatly to increase from the centres to the organs supplied by them.

EVIDENT ORIGINS OF THE CRANIAL NERVES.—As the deep origins of many of the nerves are quite uncertain, the points of emergence from the cerebral mass can alone be depended upon. The olfactory nerve takes origin from the posterior convolution of the anterior lobe by a delicate white root lying in the fissure of Sylvius. From the substantia perforata on each side of the optic commissure by an inner white root, and from a papilla of grey matter embedded in the anterior lobe of the brain. The nerve forms a bulb, which rests upon the cribriform plate of the ethmoid bone on each side of the crista galli, and sends its filaments through the foramina.

It will be remembered that the optic thalamus principally receives the crus cerebri, and that as it is not embedded in the substance of the brain at its outer and back part, there is left the fissure between it and the crus cerebri on the inner side, and the side of the hemisphere curiously rolled up into a hippocampus on the outer side, and this fissure is indeed the descending cornu of the lateral ventricle. Upon the part of the thalamus that bounds this fissure, two tubercles are found, which, from their resemblance to knees, and their relative position, are called *Corpus geniculatum, internum* and *externum*.

Now the optic nerve commences in the nates of the corpora quadrigemina which lie partly between the thalami, and extends downwards and backwards, taking an origin from the external geniculate body, then curves round the outside of the crus cerebri, and running forwards and inwards, forms the optic commissure. From its origin to the commissure it is called the Optic tract, and beyond that it becomes rounded in shape, and assumes the name of optic nerve. The outer fibres of each tract extend to the nerve of the same side, the inner ones return by the opposite tract, and the middle pass on by the opposite nerve.

The third nerve is the only one that lies on the inner side of the crus. It arises from the inner side of it, and from the locus niger.

The fourth arises from the valve of Vieussens, and curves round the outer and back part of the crus.

The fifth comes out in two masses from the side of the pons, the posterior being large, and forming the casserian ganglion, with the inner side of which the motor root is in contact.

The remaining nerves all arise from the medulla. The sixth looks like a continuation of the corpus pyramidale, as it comes from its tip. The auditory of the seventh is continued outwards from the lineæ transversæ of the calamus scriptorius. The portio dura is connected to the highest part of the groove between the olivary and restiform bodies. The glossopharyngeal of the eighth arises from the same tract, immediately below it; and still lower down, yet in the same tract, is the large pneumo-gastric nerve. As for the spinal accessory, it does not arise from any tract in particular, but is attached to the side of the spinal cord, between the ligamentum dentatum and the posterior roots of the spinal nerves, and ascends between these to enter the skull, from which, in company with the pneumo-gastric in the same sheath, and the glosso-pharyngeal, in a distinct one, it emerges by the jugular foramen. The ninth nerve takes origin from the outer border of the pyramidal body.

These are the nine nerves of Willis.

The first and second, and the greater part of the seventh, are specially sensory. The third, fourth, sixth, and ninth, and probably also the portia dura of the seventh, are purely motor. The other two are remarkably mixed, both in structure and function, and are compound nerves; and it is only upon them, of all the cranial nerves, that ganglia are developed. The casserian ganglion of the fifth, the jugular and petrosal of the glossopharyngeal, the jugular and the plexiform of the pneumo-gastric, are those referred to.

Viewing the base of the brain from before backwards, the anterior termination of the great longitudinal fissure appears between the two olfactory nerves, and stops short at a plate of grey matter called the lamina cinerea, which lies just in front of the optic commissure, extends beneath it, and, perforated by numerous arteries, forms the substantia perforata. Just behind the commissure is the tuber cinereum, with its little funnel of grey matter attaching the pituitary gland. The corpora albicantia lie just behind the tuber, and between them again is the triangular space between the two crura, called the locus perforatus posticus, also for the transmission of numerous arteries. Then comes the pons with the basilar artery in contact with its under surface, and behind this again the medulla oblongata.

The basilar artery is formed at the lower border of the pons, and gives off transverse branches as it runs towards its anterior border, where it gives off the two superior cerebellar, and then immediately divides into the two posterior cerebral, which joining with the posterior communicating from the internal carotids, form the greater part of the circle of Willis. The two carotids send forward the two anterior cerebrals, which are joined by the anterior communicating. The circle is then complete.

This circle surrounds the parts that lie between the crura cerebri and the lamina cinerea, which is the inter-peduncular space.

FUNCTIONS OF THE CEREBRAL NERVES.—The olfactory is the nerve of smell, but does not appreciate ordinary irritants. The optic is the nerve of vision, and the incident nerve for the closure of the iris. The irritation conveyed to the brain by the optic nerve is reflected by the third or motor oculi, through its connection with the ciliary ganglion, which supplies ciliary nerves to the iris. The third nerve supplies the levator palpebræ, the superior, internal, and inferior rectus, and the inferior oblique with motion. Its section or paralysis, therefore, results in ptosis (falling of the upper eyelid), dilatation of the pupil, and outward squint, for the external rectus and superior oblique muscles still continue acting. Irritation of it will cause retraction of the eyeball, and the other obvious results of excessive action in the muscles it supplies. The fourth nerve supplies the superior oblique exclusively. Section or paralysis of it will not have any obvious result, and its irritation will of course result in contraction of the muscle it supplies. The fifth, or trifacial, supplies all the parts of the head lying in front of the ears with common sensation, excepting those that are supplied by the olfactory, optic, and glossopharyngeal nerves. A particular enumeration is unnecessary if this rule be kept in mind. The anterior two-thirds of the tongue are supplied with sweet and sour taste by the fifth nerve, and motor as well as sensory filaments are distributed to the temporal, masseter, internal, and external pterygoid, and part of the buccinator; and by means of the mylo-hyoidean nerve, themylo-hyoid, the genio-hyoid, and anterior belly of the digastric are supplied with sensory and motor filaments. The fifth is the incident nerve for sneezing, and partly also for swallowing, and it is curious to observe the mode in which the act of sneezing is performed.

A sudden inspiration is taken, which is followed by closure of the glottis. The anterior pillars of the palate close, and then the muscles of expiration act with great vigour, force the air through the glottis and nares, and so clear away the obstruction to the entrance of air. Coughing has exactly the same mechanism, except that the posterior pillars are closed, and the anterior thrown open. The irritation of teething frequently produces convulsions in children, which are evidently quite reflex. Division of the nerve will simply paralyse both sensation and motion in the parts to which it is distributed, and its irritation will cause spasm of the muscles of mastication, and also intense pain. The sixth is the nerve of motion to the external rectus. Its section or irritation will produce the usual effects. The portio dura of the seventh is remarkably associated with the production of expression, as the fifth is with mastication. All muscles that express passion are supplied by this nerve, and they include all that influence the movements of the mouth, eyelids, eyebrows, and nose. The portio mollis, when it reaches the outer part of the internal auditory meatus, supplies the cochlea and vestibule, merely sending a single nervous loop into the entrance of each semicircular canal. The eighth nerve has, like the fifth, all the functions that can be possessed by white nervous matter. The glossopharyngeal is both sensory and motor to the pharynx, specially sensory to the back of the tongue, and slightly so to the soft palate, and is the principal incident nerve for vomiting, and of the feeling of nausea. The pneumogastric is also sensory and motor to the pharynx, and is the principal incident nerve of swallowing. But it also influences the heart, œsophagus, and stomach, and supplies the lungs, and indeed, the whole air tubes from the upper part of the larynx to the capillary bronchial tubes. Through it, the sensations of hunger and thirst are most probably felt. It is therefore called a nerve of organic life. Its superior laryngeal branch gives motor power to the cricothyroid muscle, and sensory power to the mucous membrane of the larynx; and its inferior laryngeal branch supplies the remaining muscles of the larynx with motion. But the exact influence which it has, independent of sensation, cannot be ascertained with regard to the œsophagus, stomach, lungs, and heart. Section of both nerves will no doubt cause asphyxia within two days, and immediate diminution of the heart's action. If the glottis be tickled or slightly irritated as by an asphyxiating gas, spasm, from reflex action, is the immediate result; and this spasm is produced by influence carried along the recurrent laryngeal nerve. But the irritation of teething and intestinal irritation in children will also cause either partial or complete spasm; if partial, then laryngismus stridulus is produced: although it is important to remember that the irritation suffered by the recurrent laryngeal nerve from enlarged bronchial glands lying under the arch of the aorta, may also produce the same symptoms, and then, of course, they do not arise from *reflex* action, but are merely the result of irritation applied along the course of a motor nerve; for, as irritation applied to a sensory nerve in any part of its course will produce sensation in the brain, so will irritation, applied to any part of a motor nerve, produce contraction in contractile tissues. The spinal accessory appears to be purely motor. The tract where the facial and the eighth nerves arise has been called respiratory by Sir Charles Bell. The ninth nerve supplies motor power only to the muscles of the tongue and depressors of the hyoid bone and larynx. Irritation of it will cause spasm of these —section of it will paralyse them.

Unless the course of nervous influence be kept clearly in view, mistakes will be continually arising; but all these may be avoided by simply remembering that motor stimuli are conveyed only in a direction from the nervous centre, and sensory stimuli only in a direction towards the nervous centre. Of the cranial nerves the fifth and eighth are certainly the most remarkable, from the large amount of grey matter which they contain, and from the power they seem to exert upon secretion. Sloughing of the eyeball has resulted from section of the fifth nerve, and this event was no doubt owing in a great measure to the dry state of the mucous membrane.

THE FUNCTIONS OF THE SPINAL NERVES are merely sensory and motor. If the anterior root be cut through, then no amount of irritation applied to the distributed part of the nerve will cause con traction, although the most intense pain will be caused. But if the smallest irritation be applied to the part of the divided root next the ganglion, muscular contraction, the result of the direct irritation will immediately follow, but not any sensation whatever will be felt. If the sensory root be divided, irritation of that part nearest the cord will produce not only sensation, but powerful reflex action in the muscles to which the nerve is distributed. Irritation of that part lying close to the ganglion will produce neither sensation nor motion. The causes of all these results are so perfectly obvious, that no explanation is at all required.

It is only by applying the general principles observed in nervous action, that the effects of pressure by tumours, injuries by mechanical irritants, &c. can be understood. The occurrence of hemiplegia (that is to say, paralysis of either the right or left half of the body), from injury of the opposite side of the brain, can only be understood by remembering that the pyramids of the medulla cross one another, and that hœmorrhage into one side of the brain is sufficient to injure its voluntary power, and so also to produce paralysis of the opposite side of the body.

In the cervical, brachial, lumbar, and sacral plexuses, the purpose of the interlacement no doubt is to maintain a proper supply of nerves to every part, by deriving that supply from a considerable extent of the cord;—for example, if any large nerve derived its component bundles merely from one part of the cord, injury to that part might entirely destroy the utility of a nerve upon which an entire system of muscles depended.

When it is remembered that the whole brain and spinal cord, during early life, were merely a continuous tube, it will not be difficult to understand how a deficiency in the deposit of nervous matter from without, inwards, should, in the fully developed state, leave such cavities as the ventricles of the brain.

It may be as well, in the last place, to recapitulate the position where grey matter is accumulated in the nervous system. *First*, on the convolutions of the brain; *second*, on the laminæ of the cerebellum; *third*, in the corpus striatum, optic thalamus, and grey commissure; *fourth*, in the tubercula quadrigemina, pineal gland, and lower part of the third ventricle; *fifth*, inside the corpora albicantia, in front of these, as far as the longitudinal fissure, and behind them to the crura cerebri; *sixth*, forming the locus niger, the grey part of the corpus dentatum, the corpus olivare; *seventh*, diffused in the medulla oblongata, and collected in the floor of the fourth ventricle; *eighth*, forming the interior of the spinal cord; *ninth*, collected in the posterior roots of the spinal nerves, and those of the eighth and fifth; *tenth*, in all sympathetic ganglia whatever.

Reproduction is accomplished by a set of changes, some of which are reflex actions, others are of a much more doubtful nature. The essential part of reproduction is the development of an embryonic cell, with the aid of nourishment, into a living being. The cell is the ovum; but what is it that makes the ovum change? Some think that the spermatozoa merely stimulate it; and just as heat might cause cell development to commence, or as a ferment might produce fermentation, or as galvanic influence might act, so the spermatozoon may be the indispensable stimulus that the ovum requires. Others, however, say, that the spermatozoon really deposits within the embryo cell the nucleus that is nourished and changed into a living being. The ovum, however, is a peculiar cell, inasmuch as it can be developed, except in rare cases, only within the uterine cavity. During its development, the germinal vesicle disappears, the yelk divides and sub-divides, forming two, four, eight, sixteen divisions, and so on, until it becomes a granular mass.

The granular mass is then changed into a cellular one, and the cells nearest the surface accumulate side by side and form a cellular membrane that encloses the yelk, and lies in immediate contact with the inner surface of the Zona Pellucida. Another layer of cells is formed within this, and after a while a third layer is formed between the two first. The triple layer of cells now formed around and enclosing the yelk, is called the Germinal membrane, and is in reality a stomach containing food ; and partly by its foldings, partly by the changes in form of its constituent cells, it shapes out the organs, and produces the textures of the fœtal animal.

The external or serous layer of the germinal membrane produces the organs of sensation and motion, as also the bones, and skin. The internal or mucous layer developes the organs of nutrition, and in the middle or vascular layer the organs of circulation are produced. It is in the united mucous and vascular layers that the liver and principal glands make their appearance.

Now there is a remarkable difference between the early condition of the larger organs, and the forms which they assume at later periods of development. For example, the brain and spinal marrow constitute at first a common elongated cavity lined by nervous matter in its most rudimentary state, and the principal organs of special sense are merely extensions of this common cavity. The heart is at first a simple contractile tube, of which the walls are composed of a thin layer of united cells, and the aorta is at first a double symmetrical tube in its whole length. The alimentary canal is an elongated cavity without either mouth or anus opening into it, and communicating only with the cavity of the yelk. The liver is a solid mass of cells, adhering to the primitive alimentary canal.

But in the farther development of the organs, remarkable changes may be seen; for example, the two dorsal primitive folds or laminæ of the serous layer close in and form the cranio-vertebral canal. The serous layer folds and unites to form the sac of the amnion. The ventricle of the heart is divided by an external notch, and separated by the growth of an internal septum into right and left ventricles. The two primitive aortic vessels coalesce and constitute one. New arterial vessels are produced in each branchial plate. The extremities sprout from the trunk. The branchial clefts form and subsequently close.

Great difficulty is usually experienced in comprehending the changes that take place in the development of the ovum; and this difficulty appears to arise in a great measure from attempts being made to account, upon ordinary principles, for changes which are simply vital, and brought about by the direct interposition of Providence. There is, no doubt, great difficulty in making a clear statement regarding processes, the observation of which is attended with so many difficulties. Besides, it is to be borne in mind that all the changes connected with fœtal development are sudden. For example, it is impossible to assign reasons for the increased thickening of the germinal membrane in one part; for its extension and folding in another; or for its partition, union, or perforation in other parts. The development of a human being is the end and purpose of all the changes that take place in the ovum; and accordingly we find the membranes to be sacculated, doubled up, amalgamated, or thickened, just as may be required to form organs and tissues.

The ovum, in its transit through the fallopian tube, obtains a thin layer of albuminous matter, which solidifies upon the zona pellucida, and with it constitutes the chorion. Previously to the entrance of the ovum into the uterus, a very thick and pulpy layer of epithelial cells forms a continuous membrane along the inner surface of the uterine cavity—this, along with the thickened mucous membrane, constitutes the *decidua vera*, It is obvious that all interchange of material between the mother and the fœtus must go on through a double layer of membrane, and therefore the circulation of the fœtus is perfectly separate from, and independent of that of the mother.

The arterial blood is poured into the placental sacs by the curling uterine arteries, and continually recedes from them into the uterine veins, which are usually termed sinuses.

As might be expected, when the placenta is cut into, it presents a cellular appearance. The fœtal and the maternal portions of it are too closely interwoven to be separated from one another.

It appears that the fœtus depends upon the maternal blood, not only for its food, but also for the aeration of its blood. For in some instances, where women have been in the habit of aborting about the seventh month, apparently from their blood being deficient in aerating power, the exhibition of chlorate of potash, from yielding an increased supply of oxygen through the maternal blood to the fœtus, has averted the recurrence of this accident.

The umbilical cord contains the remnant of the allantois, and of the umbilical vesicle, with the umbilical vein and umbilical arteries which are spirally twisted round it; these are surrounded by a quantity of cellular tissue called the gelatine of Wharton, and are all bound together by the membrane called the Amnion.

Neither absorbents nor nerves can be traced in the umbilical cord.

A FEW PATHOLOGICAL REMARKS.

I. Inflammation.—The causes that produce this remarkable change act either locally or through the blood. With the local irritants, such as heat, cold, acids, and mechanical injuries, every one is perfectly acquainted; but with the causes that act through the blood, pathologists are almost entirely unacquainted. As far as has been hitherto observed, inflammation is caused by spasm, relaxation, and loss of tone in the capillary bloodvessels. But it must not be imagined that spasm of the capillaries always results in inflammation, for the face may become white as a sheet, and yet no inflammatory change will result; nor is relaxation of the capillaries necessarily followed by inflammation, for the deepest blush may suffuse the countenance, and yet there may be no inflammatory change. What then is the exact difference between inflammatory spasm and relaxation of the capillaries, and that relaxation or spasm which is unattended with any injurious results? In answer, this ascertained fact may be stated, that spasm, followed by relaxation, if truly inflammatory, will always be characterised by the *exudation* of liquor sanguinis through the capillary walls. We are indeed quite unacquainted with anything deserving the name of inflammation, that has not this characteristic feature. The exciting cause of the spasm is sometimes obvious enough, but the spasm is not less perfect in those cases where no evident cause can be detected. When an irritant is applied to a vascular net-work, the capillaries first of all contract, and the current passes through them with greater rapidity. Presently they relax, and the current moves more slowly; and as the relaxation proceeds, the current becomes slower and slower until it stops altogether. Why does it stop? That question can be answered only by speculation; but as a very likely idea, it may be stated that the tissues have an increased affinity for the capillary contents. As in health the liquor sanguinis is never exuded in greater quantity than the tissues require, now comes the question, what is the fate of the liquor sanguinis when it is exuded in greater than healthy amount? This will depend, first, upon the quality of the fluid itself; second, upon the nature of the tissues among which it is thrown, or upon which it is exuded. The liquor sanguinis of a healthy man is plastic, that is to say, it solidifies very soon after it has come in contact with the tissues. When thus exuded, does the tissue exert any influence upon the liquor sanguinis? It does not exert much.

Liquor sanguinis, when exuded as the result of inflammatory action, may become developed into three forms of structure; namely, the Pus, Pyoid, and Exudation Corpuscles.

Pus corpuscles float in the liquor puris. They are usually 1.2500th of an inch in diameter, are globular in form, granular in appearance, swell when water is added, become transparent under acetic acid, and have generally from one to five dark-edged nuclei, with a central spot in each. Purulent matter ought to be thick and creamy, and not irritant; but unhealthy pus may be curdy or thin, or even sanious, that is to say, mixed with the colouring matter of blood. In these cases, however, the corpuscles are not globular, as they ought to be, but are ill developed, and associated with a large amount of granular matter.

Pyoid Cells have the same size as pus corpuscles. They contain from seven to twelve distinct granules, but they are scarcely affected by acetic acid, and they do not generally contain a nucleus. In what respect exactly they differ from pus corpuscles is not known, for both these structures may be associated in the same exudation.

Exudation Corpuscles are usually large, and either partially or entirely filled with granular matter. Hence they are commonly called compound granular cells. Acetic acid, as usual, dissolves the cell-wall, and permits the escape of the granular matter.

The liquor sanguinis is most likely to become developed into pus, when exuded into cellular tissue, or upon a mucous surface. Pyoid corpuscles are found only on serous membranes, and whether associated with pus cells or not, are always accompanied by delicate granular fibres, produced by the solidification of liquor sanguinis. The exudation corpuscles which, after all, appear to be formed from almost any cell by the absorption of granular matter between the nucleus and the cell wall, are usually found in softenings of parenchymatous organs, such as the brain, the liver, the kidney, &c. They are usually of large size, and sometimes granular matter, quite identical with that observed within their cavities, has been found encrusting capillaries in various parts.

Now, it is a remarkable fact, that if an exudation be developed otherwise than in the manner now stated, the case is generally a bad one. For example, if an exudation be thrown out upon a mucous surface, and solidify upon that surface, thereby forming a false membrane,—in other words, if the exudation be plastic,—then almost to a certainty, typhoid fever will also exist. And in the same manner, if an exudation into a serous sac assume the purulent form, again the symptoms will almost for certain be typhoid—and by typhoid is to be understood the concurrence of brown and furred tongue, low muttering delirium, and a pulse increasing in rapidity while it diminishes in strength.

The diphtheritic sore throat, in which there may be something approaching to a false membrane covering the fauces, extending up into the nasal region of the pharynx, down into the larynx, and perhaps into the trachea, is an excellent example of the plastic affection on mucous membranes being accompanied by typhoid symptoms.

Supposing that a quantity of liquor sanguinis is exuded into the pleura or pericardium, of a patient who up to the time of attack had been quite healthy, this exudation almost immediately solidifies; and if it can be examined in this state, it seems to be composed of minute granular fibres, crossing one another in every direction. Gradually corpuscles begin to appear, and these corpuscles are either nucleated or not. In the former case they are fibro-plastic cells, in the latter, they are the plastic or pyoid cells of Lebert.

Now, this constitutes plastic lymph, and may become organized into cellular tissue, but into nothing higher. Its bloodvessels are formed in one of two ways, either in the mode already stated, by the branching out and union of the branches of cells, or, which is more probable, by the capillaries of the tissue upon which the exudation lies becoming varicose, and dilating in such a manner as to become continuous with one another. That is to say, the capillary walls, by dilatation, project like tendrils into the exudation, and meeting with one another, coalesce to form vessels.

The formation of the cellular (areolar) tissue may always be explained in the same way, namely, by the elongation and splitting up either of the pyoid or fibro-plastic cells. As development goes on, the organized lymph contracts, partly by its fluid part being absorbed, partly perhaps by a sort of contraction peculiar to itself. It consists of the white and yellow fibrous tissue, and sometimes even appears to possess contractility : for scarcely on any other principle could the firm contraction of a stricture which has been widely dilated by bougies be explained. Elasticity alone will not account for it.

The fibrous appearance assumed by the lymph when it first solidifies, is in a short time replaced by the more permanent fibrous tissue developed from the cells.

In the course of an inflammatory attack, the longer its duration, the less will be the disposition of the exuded liquor sanguinis to coagulate. In fact, as the strength diminishes, so does the plasticity or vitality of the liquor sanguinis.

Those cases called hæmorrhagic pleurisy, and pericarditis, which sometimes occur, are to be looked upon as the result of inflammatory softening in the newly-formed capillaries of the exudation, and hæmorrhage from them.

When lymph is exuded between periosteum and bone, then it may assume something of the appearance of cartilage. The cartilaginous mass in this case really has a fibrous structure, and osseous deposit may take place in it—a *chronic node* being the result.

The specific inflammations are the *rheumatic*, the *gouty*, and the *syphilitic*, to which should perhaps be added the *scrofulous*.

As a general rule, rheumatic inflammation does not proceed to the formation of pus, but generally affects the fibrous tissues surrounding joints; and if it does appear to affect muscular substance, most likely it selects their fibrous investments for its especial seat. One of the most marked characteristics of this inflammation is its disposition to shift its position from joint to joint—from the large ones, in which it usually commences, to the smaller ones; but more especially it is interesting from its tendency to shift to the heart, and often also to the pleura and lungs, and especially in the endocardium, to leave traces of its power that can never be effaced.

The gouty inflammation, on the other hand, begins in the smaller joints, afterwards affecting the large ones. It is accompanied by brighter redness, greater swelling, and pain more intense and paroxysmal in its character, than belong to rheumatism. Also it is the synovial membrane that is in the greatest degree affected. But what marks it out most of all is the peculiar deposit of urate of soda which may afterwards occur immediately around the synovial membrane, constituting the gout chalkstone.

There is no certainty in regard to the sort of affection existing in the so-called gout in the stomach. Neither, indeed, is it established that the stomach is affected at all.

The syphilitic inflammation affects the genital organs, where it commences by the formation of a papule, which becomes a pustule, then bursts and forms an ulcer. But if excoriations already exist, a venereal ulcer may be established by the contact of venereal matter. After the occurrence of the local disease, a remarkable train of consequences, or "secondary symptoms," may be developed, comprising cutaneous eruptions of the squamous and pustular kinds, sore throat, and subsequently chronic inflammation of the fibrous and osseous textures, as well as of the lymphatic glands.

The diseases, however, that occur in syphilis, are merely inflammations of the ordinary kind, modified by the constitutional taint.

II. MORBID NUTRITION—NON-INFLAMMATORY.

As the term inflammation is so perfectly associated in our minds with redness, swelling, heat, and pain, excessive exudation taking place without these symptoms, is called non-inflammatory, and must continue to receive that name. Such exudation may become developed into Cancer, Tubercle, and Typhoid Matter.

Cancerous Matter, like other organizable material, consists merely of oil, albumen, and salts; and is characterised by nothing so much as by its disposition to continual cell-growth. Setting aside the degraded state into which the blood must have passed before the exudation took place, all the evil effects of cancer may be traced to the result of pressure upon the surrounding parts. It is well known, that in all tissues, except cartilage, nails, and others that are non-vascular, nothing produces such a powerful disintegrating effect as pressure. By the growth of cancer the tissues are melted down, and upon this melted material the cancer lives. It ought always to be recollected that the cause of its being called Cancer, was its spreading out like the claws of a crab.

Cancer cells are generally large, and may contain a couple of nuclei about the size of pus corpuscles, which again contain nucleoli about the size of blood discs; but this statement has reference merely to the appearance of ordinarily developed cancer cells; for they may become very large, and contain many cells, or nuclei, whichever the histologist may choose to call them. And again, in their early development they are not distinguishable from any other cells. Therefore it is only by watching their development that any proper conclusion can be arrived at.

In the rapidly growing tumours there are always many free nuclei.

There are three varieties of cancer, namely, the hard, the soft, and the gelatiniform. All three may be found existing in the same individual; and it is not always possible to determine which of these exactly the tumour should be referred to.

Hard cancer, also termed schirrus, has the consistence of cartilage, and cuts like it, or, as it is said, "cries under the knife." It may occur in the lip, mamma, uterus, and testicle; but in the last it is very rare. It consists of cancer cells, embedded in a dense matrix of fibrous tissue. The source of the fibrous tissue is rather uncertain, although it is supposed to be chiefly the cellular tissue of the organ itself.

The Soft cancer, also called cerebriform or medullary sarcoma, may occur in any parenchymatous organ except the brain,—at least it has not as yet been found there. It may also take place in any organ that contains cellular tissue, therefore of course in bones, &c. It consists of cancer cells, with much granular and nuclear matter, but comparatively few fibres. It grows very fast, is elastic to the touch, and when it ulcerates, the result is a highly vascular sprouting tumour called *fungus hæmatodes.*

Colloid cancer, also called gelatinous, glue-like, or areolar, occurs in the sub-serous cellular tissue investing internal organs. It consists of cancer cells embedded in a very regular fibrous net-work, and associated with a large amount of a jelly-like fluid. It is important to know that this variety of cancer, when it takes place in the ovary, may be cured spontaneously by the ulceration of its investment, and escape of the jelly-like fluid, which is at once absorbed by the peritoneum, into which it is thrown.

A fourth variety of cancer is described, namely, the melanic; but this is merely the association of melanotic matter with the ordinary elements of cancer.

Cancerous tumours are the only ones that are truly malignant; although the term malignant is altogether rather an absurd one.

Tubercle consists of very ill developed cells, often irregular in shape, and not larger than blood cells, besides which there is a great quantity of granular matter. Crystals of the triple phosphate exist in all the chronic deposits.

The history of tubercle is best known in regard to the lungs. It is deposited first in little particles about the size of millet seeds, hence called miliary tubercle; then it accumulates in little masses in the upper part of the lung, but it never increases so as to form large deposits in any texture. It looks in fact as if it had been poured into the tissue, quite in a semifluid state, and had then become solidified.

Tubercle may occur wherever there is cellular tissue, and its frequent occurrence in the articular extremities of bones, in the bodies of the vertebræ (constituting the cause of scrofulous caries), and elsewhere, renders it of the highest consequence.

Both in cancerous and tubercular diatheses there is a remarkable increase of albumen in the blood, of course to the diminution of the yellow corpuscles. But in tubercle especially, albumen is thrown out in remarkable quantity, being even passed by stool; and there is no indication of the scrofulous diathesis more striking than the occurrence of albuminous discharge from the genital organs in female children.

The albumen seems to require oil for its organization, and therefore the employment of cod-liver oil has often been followed with the best effects, although it does not appear that this is anything else but an aliment.

Typhoid deposit has the colour of yellow ochre, and takes place in the submucous tissue, surrounding Peyer's patches, sometimes ulcerating its way into the intestines, sometimes piercing the peritoneum. It occurs along with typhoid fever, the disease being then called *Dothein-enterite.* Ulcerations that occur on the intestinal mucous membrane vary in their appearance according to their cause. From typhoid deposit, the ulcers in general are elongated and oval, have rather a greenish appearance, and their long diameter corresponds with that of the intestine. The long diameter of the tubercular, on the contrary, generally runs across the small intestine; while simple ulcers may lie in any direction.

When typhoid matter is examined, it is found to consist, according to its stage of development, of a material very like organized tubercle, or it may present very large cells, granular in appearance, furnished with nuclei. These nuclei are composed of numerous very small smooth nucleoli, which, under the action of acetic acid, separate, many of them escaping, and being then called naked nucleoli.

Non-malignant tumours resemble either the cellular, the fibrous, or the fatty structure. They are,—*first*, the simple vascular sarcoma, resembling a mass of cellular tissue; *second*, the fibrous tumours, having the appearance of dense white fibrous tissue, sometimes arranged so that they look like balls of cotton; and, *third*, the fatty, which may be either loose and lobulated, or more dense and laminated.

Cysts are themselves formed out of fibrous tissue, and may exist either separately, as encysted tumours, or, being embedded in the substance of the simple vascular sarcoma, or of the fibrous tumour, they constitute fibro-cystic or cellulo-cystic tumours. The contents of the cysts differ greatly; but are generally either *atheromatous*, *steatomatous*, or *meliceritous*, according as they have the consistence of putty, or fat, or honey. Sometimes they contain melanotic, sometimes cancerous matter; and in the ovary, those that contain an oily fluid will in all likelihood contain also hair, incisor teeth, bones, &c.

The tumours of bone have the consistence either of bone itself, or of something softer. In the former case, the tumour may resemble either dense bone, when it is called an *ivory exostosis;* or the cancellated texture of bone, when it is termed a *cancellated exostosis;* and this may be either smooth or spiculated on the surface. In the latter case, the tumour will most likely possess the density, if not the structure of cartilage. Of course, if the tumour be of the malignant kind, its nature will soon become obvious.

Although cellular, fibrous, and fatty tissues, with or without the cysts already mentioned, are the only tumours, commonly called analogous; yet as epithelium may become developed to a very great degree, this, together with increased vascularity of the subjacent tissues, may constitute warty or other growths. And considering how readily the osseous texture is produced, it will not be wonderful if deposits of carbonate or phosphate of lime occur in the ordinary kinds of tumours. It is in fact, only the uniting, protecting, and supporting tissues, that do hypertrophy in the true sense of the word.

Muscular and nervous tissues never hypertrophy except from increased exercise, and wherever muscular substance is increased, whether it be in the extremities, in the trunk of the body, or in the walls of the heart, in all cases enlargement has taken place for the purpose of enabling the structure to perform its functions, when otherwise it would be unequal to the amount of work required of it.

Enlargement of the heart, which is so very frequent, is merely the result of an obstructed circulation, on account of the blood being thrown back on the ventricles or on the auricles, by the valves not exactly closing.

The hypertrophied muscular coat of the bladder, resulting from obstruction to the exit of urine by stricture of the urethra, is familiar to every one; in the same manner, the muscular coat of the stomach may become thickened by chronic vomiting; and increased muscularity of the great intestines in cases of obstruction to the passage of the fœces, is the result of constipation, and of the continued effort to drive on the intestinal matter.

Nervous tissue hypertrophies very little; and when muscles increase greatly in size, the nerves that supply them do not suffer a corresponding increase. Tumours may grow upon nerves; but these consist merely of cellulo-fibrous masses, separating out the nervous fibres.

Perhaps the most remarkable example of hypertrophy in muscular substance is that of the pregnant uterus; for here, without any cause that would be sufficient to hypertrophy any other organ, it distends and grows to an enormous size, and finally acts for the specific purpose of expelling the fœtus from its cavity.

But in this instance it is to be remarked, that the uterus is really in an undeveloped state until an ovum comes to be developed within it, and that the great increase of muscular substance is only to be considered as the perfection of its development.

In regard to the hypertrophy of glands it may be stated, that on the removal of one kidney the other becomes enlarged, since it has to perform the functions of both. But there is no reason to think that the same rule applies to the lungs, or perhaps to any other gland.

The Degeneration of Tissue is either atrophy, or else the result of mechanical or chemical agency.

Simple atrophy results from a simple defect in the supply of blood; the organ diminishes in size because it does not get sufficient food. It gets enough to hinder it from dying altogether, but not sufficient to keep it in full vigour. The most natural examples of this are the almost entire obliteration of the thymus gland, and of the structures existing in fœtal life only. The atrophy of muscle is well exemplified in the case of Indian fanatics.

When fatty degeneration takes place in a secreting organ, oily matter is first poured into and occupies the secreting cells, and by its accumulation presses upon the tissues of the organ, so as to diminish the amount of blood sent to it. As the cells do not secrete, of course the same amount of blood is not supplied to the organ, and therefore the capillary vessels shrivel up. But the result of pressure appears to be either the splitting up of the membranous tissues that compose the organ, or their reduction to the condition of molecules and granules. In this way it is easy to account for the appearance of granular degeneration, which used to be referred to the exudation and organization of lymph in the tissues of glands, as the liver. This, properly speaking, is the result of mechanical pressure, and consists in the reduction of the membranous and tubular elements of a gland into the state of simple areolar tissue.

But there is another kind of fatty degeneration which may have results not less serious than those of the first kind. This is really a chemical degeneration, and consists in the reduction of highly nitrogenized sarcine, contained in muscular fibres, to the condition of oil containing no nitrogen. This is well seen not only in the voluntary muscles, such as the sartorius, but also in the muscular substance of the heart. In this latter situation it may be the cause of death.

There are, indeed, no degenerations that may not be referred to one of these varieties already stated. Such changes as those of the crystalline lens, in cataract, are probably owing to exudation occurring between the layers of that structure.

The degeneration of the middle and internal coats of an artery, including the circular, longitudinal, and Henlé's coat, is in the highest degree important, as it destroys the elasticity of the organ, and so renders the supervention of aneurism very easy. The arteries being no longer elastic, yield before the pressure of the onward current, but are unable to resile. If the softened coats should remain unruptured, then the affected vessel may become sacculated, in various ways, to constitute spindle-shaped, cylinder-shaped, or other forms of true aneurism. But as the softened coats generally yield after a time, the outer coat alone of the artery remains as the covering of the aneurism. Although the effect of ossific deposit in the coats of arteries will also be to diminish the resilience, and so produce aneurism, yet this cause is rare.

The changes that occur in the coats of veins, when they become varicose, are not known. They appear to suffer degeneration of the yellow elastic tissue found in their contractile fibrous coats.

The cause of the varicose state of the arterial coats that constitutes arterial varix, is not known.

The real nature of aneurism, by anastomosis, appears to be the excessive development of the capillary bloodvessels, which become large, tortuous, and dilated, as well as thickened in their coats.

PART II.—ANATOMY.

THE SKULL.—The parietal bones are firmly knit to one another by the *sagittal* suture, to the frontal bone by the *coronal*, and to the occipital by the *lambdoid* suture. The temporal bones support the parietal at the squamous sutures, and their petrous portions project forwards and inwards into the base of the skull. The cranial surface of the ethmoid bone fills up the notch between the orbital plates of the frontal, and the sphenoid occupies the remaining part in the interior of the skull. Of the three fossæ in the base of the skull, the anterior lodges the corresponding lobes of the brain, and its posterior border, formed by the lesser wing of the sphenoid, exactly corresponds with the fissure of Sylvius. The middle fossa, bounded behind by the upper border of the petrous bone, lodges the middle lobes ; and the posterior fossa, which is limited by the attachments of the tentorium cerebelli, contains the hemispheres of the cerebellum with the medulla and pons.

The dura mater closely invests the inner surface of the skull, and its attachment is strongest at the sutures. It is a dense fibrous membrane that splits into two layers in certain situations, thereby forming channels along which the veins, almost deprived of their outer coats, are continued to form the sinuses.

As the outer layer of the dura mater is in close contact with all the elevations and depressions on the inner surface of the skull, it is only necessary to know in what situations the inner layer separates from the outer, to know also where the sinuses are.

In the first place, it must be kept in mind that the falx cerebri, falx cerebelli, and tentorium cerebelli, are formed exclusively by the inner layer of the dura mater—the outer layer always remaining in the closest contact with the inner surface of the skull. With the exception of the inferior longitudinal, which lies in the lower border of the falx cerebri, and the straight sinus which lies in the line of junction of the tentorium and falx, all the sinuses within the cranium are formed just along the line of separation of the inner from the outer layer of the dura mater. This separation takes place along the groove which extends from the foramen cœcum to the internal occipital protuberance; along the grooves that channel the occipital and temporal bones; along the upper borders of the petrous portions of the temporal bones; along the grooves that lie between these and the basilar process of the occipital; on each side of the sella turcica, also in front and behind it; and lastly, across the basilar groove on the occipital. All these channels, so formed, are continuous with one another, and are called superior longitudinal, lateral, superior and inferior petrosal and cavernous, which last, with the anterior and posterior connecting branches, constitute the circular sinus that surrounds the pituitary body in the sella turcica, and finally, the transverse sinus.

The falx is shaped like a sickle, and is attached to the crista galli in front, to the upper surface of the tentorium behind. The tentorium itself is stretched almost horizontally between the attachments of the superior petrosal and horizontal portion of the lateral sinus on one side, and the same parts on the opposite side. The falx cerebelli stretches from the internal occipital crest to the under surface of the tentorium, and near its line of separation two occipital sinuses form channels as they run up to join with the superior longitudinal and lateral at the dilatation called torcular Herophili in front of the internal occipital protuberance. Counting this last point of junction as a sinus, there are altogether sixteen sinuses within the skull; but of these the cavernous are certainly the most remarkable. Their cavities are crossed by fibrous bands, and between the dura mater and the venous membrane, on the inner side, lies the carotid artery, with the sixth nerve just against it. While in the outer wall also, between the vein and the dura mater, the third, fourth, and ophthalmic division of the fifth, lie in the order of their numbers from above downwards, and from without inwards.

It must be again brought to mind, that the falx cerebri and cerebelli are all continuous with the tentorium, and that there is a little excavation in the front of this nearly horizontal septum for the passage of the medulla.

As the dura mater is separated from the pia mater by the double fold of arachnoid membrane, its supply of blood is therefore derived in a great measure from other sources besides the internal carotid and vertébral arteries.

The internal carotid artery, besides its other branches, supplies the dura mater with anterior meningeal arteries; the ascending pharyngeal and occipital supply inferior meningeal, that pass through the middle and posterior lacerated foramina; the internal maxillary sends the middle and small meningeal through the foramina spinosum and ovale; and the vertebral supplies posterior meningeal to the back part of the dura mater.

The branches of the internal carotid are all given off within the skull, and partly enter into the circle of Willis, and partly are distributed in other directions. They are the posterior communicating; the anterior cerebral, which curve up and lie on the corpus callosum; the middle cerebral, lying in the fissure of Sylvius; the ophthalmic, which enters the orbit; and finally, the tympanic choroidean and anterior meningeal.

The vertebral arteries give off inferior cerebellar to the hemispheres of the cerebellum.

Taking a survey of the inner surface of the skull in the mesial line, the foramen cæcum lies in front of the crista galli and transmits a small vein. On each side of the crista, the under surface of the olfactory bulb sends downwards through the cribriform plate three sets of nerves, the outer of which are firmest and pass through osseous canals in the ethmoid, the inner, which are softest, ramify on the septum, and the middle set supply the roof of the nasal fossa. The filaments are ramified in the mucous membrane, and supply its upper two-thirds. Just behind the ethmoid is seen the transverse groove on the sphenoid, which supports the optic commissure, leading to an optic foramen on each side, through which passes the optic nerve surrounded by a dense covering of dura mater with the ophthalmic artery outside and below it. Just behind the transverse groove is the sella turcica, with the posterior extremities of the lesser wings of the sphenoid overhanging it in front, and the posterior clinoid processes projecting behind. Just behind the sella turcica is found the basilar groove on the basilar process leading to the large oval foramen magnum, which transmits not only the medulla oblongata and its membranes, but also the vertebral arteries, spinal accessory nerves, and minute vessels belonging to the medulla itself. In the middle fossa of the skull, four of the remaining cranial nerves emerge, and in the posterior fossa the remaining three. Just under the lesser wing of the sphenoid, lies the anterior lacerated foramen transmitting the third, fourth, and sixth nerves to the muscles of the orbit, along with the ophthalmic division of the fifth, a small branch of the sympathetic, and the ophthalmic vein. These are enclosed by sheaths of the dura mater, which is here prolonged into the orbit, to form its periosteum. Just below this foramen, lies the foramen rotundum, which transmits the upper maxillary of the fifth. And just behind it again, the larger foramen ovale for the lower maxillary nerve. The foramen spinosum, for the middle meningeal artery, lies just behind the ovale; and the artery itself grooves the inner surface of the temporal and parietal bones as it ascends in the cranial vault. Just to the inner side of these last foramina, is seen the unroofed portion of the carotid canal with the little depression just above it for the lodgement of the Casserian ganglion. The *foramen lacerum basis cranii* is found close to the side of the sella turcica, at the point of the petrous bone. It is filled by a fibrous plate which is traversed from before backwards, by the vidian nerve, as it emerges in the thickness of the bone at the posterior extremity of the vidian canal.

This nerve then runs along the front of the petrous bone, and enters an aperture called the *Hiatus fallopii*, where it joins with the facial nerve.

The casserian ganglion and the vidian nerve both lie under the dura mater.

In the posterior fossa, the large internal auditory foramen first arrests attention, and lies just about the centre of the posterior surface of the petrous bone. It transmits the portio mollis with the portio dura, resting in a groove on its upper surface with a small artery between them.

Just between the occipital and temporal bones is the posterior lacerated or jugular foramen, through which all the blood from the cranium and its contents emerges by the junction of the inferior petrosal with the lateral sinus; and just to its inner side, close to the margin of the foramen magnum, is the opening for the ninth nerve.

The shallow groove on the mastoid portion of the temporal bone presents the aperture of the mastoid foramen for the transit of a vein to the lateral sinus.

As the surface of the cerebellum is not convoluted like that of the cerebrum, of course the posterior occipital fossæ are smooth.

In the construction of the skull every method has been adopted to render the structure unyielding by the thickness of the occipital, petrous parts of the temporal and sphenoid bones; for the important parts of the base of the brain could not suffer compression without their function being destroyed. Moreover, the delicate structures connected with hearing, require the fullest protection by a very hard shell. Before birth, vacuities are left in the development of the cranium at the anterior and posterior fontanelles; and at these parts, where the membrane has not become ossified, pulsation may still be felt as the impulse from the heart acts upon the brain. Any diminution of size that the head may undergo during labour, results from overlapping of the parietal bones, certainly not from compression of the head from before backwards, or at the base.

Neither in very young, nor in elderly people, is diplöe found; for in youth the bones are comparatively soft, while in old age the diplöe is absorbed. The outer table of the skull is tougher and thicker than the inner, which is called, from its hardness, the Vitreous. The cancellated texture, or diplöe, lying between these, contains the veins by which the blood is returned into the triangular cavity of the superior longitudinal sinus, from the osseous texture, and likewise from some of the structures outside the skull. These veins open from behind forward, and so obstruct the current from the foramen cœcum.

In regard to severe Concussion, the worst cases are those in which no fracture has occurred, and although the sutures are obviously for the purpose of distributing the force of a blow, yet, unless some escape from very severe injury is afforded by the occurrence of fracture, the consequences are more likely to be fatal. The periosteum is very likely to be torn, and perhaps some vessels to be ruptured.

Of fractures of the skull, those at the base are the most certainly fatal, not only from the inflammation that is sure to come on, but also from other injuries, not so apparent, which the patient may have sustained from the shock that produced the fracture.

Punctured fracture, which may result from the blow of a pick-axe or the corner of a shovel, will require immediate trephining, whether there be symptoms of compression or not, because the splintering of the internal table is sure to result in inflammation, whether early or late.

Compound fracture, with depression, and urgent symptoms of compression, will require immediate trephining to elevate the depressed bone.

If the fracture be simple and depressed, then treatment may be employed to relieve the symptoms; but if no relief be found, then the trephine must be used.

Dura matral abscess usually occurs after concussion, and is almost always the result of carelessness on the part of the patient himself. Having received a blow from which he has all but recovered, feeling not quite well, but unwilling to curb his appetite, he goes out to dinner, takes too much wine, gets stupid on the way home, and soon becomes comatose on his arrival there. The lacerated vessels of the dura mater have not been entirely healed, and readily take on inflammatory action under the influence of the fresh excitement. This is the usual history of such cases, in which the rapid exudation of liquor sanguinis, which becomes changed into pus, between the dura mater and the skull, causes the most urgent danger. In this, as in all other cases attended by symptoms of compression, the slower and the more interrupted the breathing, the less the power of the spinal cord over the sphincters, the greater also will be the danger and the necessity for immediate interference.

Diagnosis between concussion and compression.—The only way to remember the distinction is to fix in the mind the features that present themselves in each case.

In concussion, the pale face, cold surface covered with a clammy sweat, the calm and scarcely perceptible respiration and the small regular pulse, the ease with which the patient is roused from his state of insensibility, all indicate his condition. The pupils are generally contracted, but one may be dilated ; and the pulse becomes rapid when the patient is aroused.

In compression, however, the warm surface, perhaps covered with warm perspiration, the flushed face, the laboured, often stertorous breathing, the slow and labouring pulse, and the deep insensibility from which the patient cannot at all be roused, sufficiently distinguish the case. The widely dilated pupils and their perfect insensibility to light, indicate the suspension of all sensation.

It must not be imagined, however, that exactly the characteristics now mentioned will always exist, as it is impossible to predict to what degree a man may be injured in falling from a height ; and the deep insensibility with convulsive m of the limbs, sometimes observed to a severe injuries, must result from an affe only of the brain, but of the spinal cord examining any case, the behaviour of matter under shock, diminution, and in pressure, must always be carefully borne

When trephining must be perform care should be taken not to injure mater. As a general rule, trephining situation of the great sinuses must be avoided. The successful result of tr when it has been performed over the artery in cases of extravasation of bloo be considered as affording any warrant practice in general. The existence of dura mater may perhaps be indicated effusion into the subcutaneous cellular vering the part. This is "Pott's puffy and if there be a wound, its surface wil glassy, but no external indications ma internal abscess even when coma ha vened.

Fossæ around the Cranial Cavi orbital and nasal fossæ communicate through the sphenoidal fissure and cribri with the cranial cavity; but the remaining four fossæ do not.

Of the twenty-two bones that form the head, fourteen belong to the face, and of these the lower jaw is the only one that does not assist in forming either the orbital or the nasal fossæ. All the remaining bones, except the malar, assist in forming the nasal fossa; all, excepting the nasal, the vomer, and the inferior turbinated aid in constructing the orbital.

The orbital fossa is a pyramidal cavity, with its apex behind. The frontal, malar, upper maxillary, and lachrymal, form its anterior part; the sphenoid, ethmoid, and palate, its posterior. The optic foramen lies furthest back, and is separated from the sphenoidal fissure, which lies just outside of it, by the border of the lesser wing of the sphenoid. Between the os planum of the ethmoid and the orbital plate of the frontal, lie the posterior ethmoidal foramen for an artery, and the anterior ethmoidal for an artery and the nasal branch of the ophthalmic nerve. It may just be stated, that this nerve immediately enters the skull, and, running along the cribriform plate, perforates it in front and enters the nose, which it supplies by an external and an internal branch. The groove on the lachrymal bone, which lodges the lachrymal sac, continues down into the lachrymo-nasal canal, which lodges the nasal duct, and runs downwards, outwards, and slightly backwards, to the lower meatus of the nose. The spheno-maxillary fissure lies between the orbital plates of the sphenoid and upper maxilla, and is crossed by the upper maxillary nerve and infra-orbital artery, which run in a canal of the maxillary bone, and escape at the infra-orbital foramen. This nerve gives off in its passage, first a delicate temporo-malar nerve, then two perpendicular branches to Meckel's ganglion; and after supplying the teeth of the upper jaw with posterior and anterior dental branches, it ramifies in the integument and muscles of the face as far down as the upper lip. The temporo-malar foramen lies in the malar bone and divides into two canals, which open on the cheek, and in the temporal fossa. The supra-orbital foramen transmits the remaining part of the frontal nerve, after it has supplied the supra-trochlear, to communicate with the infra-trochlear branch of the nasal around the pulley for the superior oblique on the internal angular process of the frontal bone. Including the large aperture in front, the orbit has ten openings.

The contents of the orbit are the eye-ball, the muscles that move it and the upper eyelid, the nerves that supply these with sensation and motion, the arteries, the fat that pads up the back of the orbit, the lachrymal gland that occupies its upper and outer part, the lachrymal sac at its inner and lower part. But as the periosteum of the orbit lies next to the bones, it properly speaking contains all these parts; and stretching down from the upper margin, and up from the lower margin of the orbit, it attaches the thin cartilages that give form to the eyelids, and lodge the numerous parallel Meibomian glands which open on their borders, and look like a string of beads. The levator palpebræ stretches out like a fan on the inner surface of the eyelid, and the mucous membrane covers its inner surface, as well as that of the lower eyelid, before being reflected on the front of the eyeball. The outer surfaces of the eyelids are covered with a thin layer of orbicularis palpebrarum, which on them is semi-voluntary, and the tendo oculi not only gives attachment to this, but firmly connects the eyelids to the nasal process of the upper maxillary. The Caruncula lachrymalis lies internal to and between the apertures for the lachrymal ducts, and obstruction of these may give rise to *Epiphora* (watery eye). Obstruction of the nasal duct, whether arising from syphilitic or other disease in the upper maxillary and inferior turbinated bones that form its canal, will cause distention, inflammation, and suppuration of the lachrymal sac, most likely resulting in an external opening beneath the inner canthus of the eye for the escape of the tears. Remembering the direction of the canal, it is only necessary to push a narrow knife through the fistulous aperture into the nose, so as to restore the canal, and then by keeping open the nasal orifice, to effect closure of the false one. But keeping the canal open is no easy matter; and the patient generally requires to wear a gold needle in it, with the head projecting below the canthus.

A fleshy growth, apparently a hypertrophy of the mucous membrane, may extend from the inner canthus to the cornea, in which case it is called *Pterygium;* but if it extends round the cornea, it constitutes *Pannus.* These may be treated by taking out a small part of the growth just outside the canthus, and thereby cutting off the supply from its margin. *Ectropium*, which may result from great thickening of the conjunctiva, may be treated by touching the conjunctiva with nitrate of silver, or by clipping off a little bit in such a manner that the cicatrix may contract and bring the eyelid back to its place. *Entropium* will require partial excision of the integument of the eyelid. In *Conjunctivitis*, the tortuous vessels of the conjunctiva run in bundles towards the margin of the cornea, where, in the most violent cases, they constitute a thick vascular ring around it; this is *chemosis*, and may cause the cornea to slough by obstructing its nutrition. To obviate danger, a little bit of this thickening may be cut across, and this will empty the vessels. Simple conjunctivitis requires merely leeching at the inner and outer angles of the eye, warm fomentation, and protection from light. The purulent variety, however, which is generally caused by the contact of gonorrhœal matter, is very rapid, and requires different treatment. A solution of nitrate of silver (10 gr. to the ounce) is to be dropped into the eye, other means being taken to reduce the inflammation. Strumous conjunctivitis is not marked so much by great injection of the conjunctiva as by the most painful intolerance of light: the child (for it is generally in children that it occurs) buries its face in the nurse's arms, for fear of being exposed to the light. Attention to the constitution ; cod-liver oil, &c. along with proper cleanliness, ensured by separating the eyelids, so as to allow the escape of matter lying between them and the surface, is quite necessary. There is nothing about conjunctivitis of every variety more remarkable than the kind of pain: it is, as in other mucous membranes, of a burning kind, but especially there is a feeling just like that of sand rolling about in the eye. Very often the patient cannot be convinced that there is not sand in it.

Structure of the Eyeball. The eyeball consists of the aqueous, crystalline and vitreous humours for the transmission of light, of the iris to regulate its amount, and of the retina to receive the impression. The coats of the eye, as they are called, are all incomplete in front, and serve for the protection of the more delicate parts within.

The sclerotic forms five-sixths of the outer surface of the globe, and is completed in front by the transparent cornea, which is part of a smaller sphere, and is nicely wedged into it. The conjunctiva covers the front, the elastic cornea supports the back of the true cornea, which is itself composed of four layers with interposed areolar tissue and fluid. The ciliary ligament corresponds to and amalgamates with the junction of the sclerotic and cornea in front, attaches the iris internally, the venous layer of the choroid externally, the ciliary processes, and, therefore, the hyaloid membrane posteriorly. The crystalline lens is an exquisitely transparent double convex body, composed of concentric laminæ arranged like the scales of an onion, enclosed in a delicate capsule, and embedded to half its depth in the front of the vitreous humour.

The vitreous humour has the consistence of jelly, and is intersected in every direction by delicate fibrous plates, sent inward from the hyaloid membrane, which is its capsule. It is globular in form, but hollowed out in front, for the reception of the lens. It maintains the form of the eye, and gives gentle support to the retina. The hyaloid membrane, like the elastic cornea and capsule of the lens, is structureless. It is attached in front around the margin of the capsule of the lens, and just where the radiating ciliary processes rest against it, it presents, of course, a circle of radiated folds, and this appearance is called the Zonule of Zinn. Just behind this, a triangular channel, formed in the vitreous humour, encircles the lens. This is the canal of Petit.

The retina consists of the expansion of the optic nerve and minute ramification of the arteria centralis retinæ, between layers of nerve cells and nuclei. The nerve fibres interlace as they run forward, but become so indistinct anteriorly that their mode of termination cannot be ascertained. The capillary net-work is rather external to the nervous expansion, and so is the greatest part of the clear granules or nuclei.

Jacob's membrane constitutes the outer part of the retina, and lies next to the pigment cells of the choroid. It consists of long club-shaped bodies, arranged perpendicularly to the surface in half-dozens, with larger bodies between the bundles. The anterior border of the retina is scolloped to fit against the posterior border of the ciliary processes. In the axis of vision, a yellow spot, half a line in diameter, marks the retina, and in its centre is the minute foramen of Sœmerring, over which the nerve fibres are deficient. One-eighth of an inch to its inner side the optic nerve breaks up, and its central artery divides into branches, none of which cross the yellow spot.

The choroid coat, which is perforated by the optic nerve, consists of a delicate pigment mem brane containing pigment cells, and of a fine capillary and villous-looking net-work outside of this called the Tunica Ruyschiana. The arteries of the choroid are the short ciliary, which run forward nearly parallel with one another, and thus form a net-work. The veins, which are arranged in parallel arches, and open into two trunks on each side of the eyeball, have been called Vasa vorticosa, from their whirl-like appearance. But the dense interweaving of the minute veins and arteries close to the pigment layer prevents the separation of any but the larger arteries and veins. The pigmentary matter infiltrates all the choroid, and stains it of a chocolate-brown colour, and parallel to the axis of the eyeball the long ciliary artery and nerve run forwards, the former to the iris, the latter to the ciliary ligament. The short ciliary nerves, from the lenticular ganglion, lie in channels on the inner surface of the sclerotic, and supply the iris. The arterial layer of the choroid folds inwards upon itself and forms the ciliary processes, which are seventy or eighty in number, intensely vascular and covered with a dark pigment. These encroach partly on the posterior surface of the iris, and with it and the lens, constitute the limits of the posterior chamber of the eye.

The pupil is merely a little round window capable of opening and contracting in such a man- as to allow no more than a sufficient quantity o light to enter the dark chamber which contain the lens and vitreous body. When the retin ceases to feel the impressions of light upon it, then the pupil remains stationary: for why should i alter its size when the retina is indifferent?

The muscles of the orbit arise round the opti foramen.

The superior rectus, levator palpebræ, an superior oblique arise from the upper margin o the optic foramen, and from the fibrous sheath o the optic nerve. The inferior, internal, and on head of the external rectus, arise by a commo tendon, called Ligament of Zinn, around the lowe part of the same foramen. The other head o the external rectus is attached to the upper margin of the sphenoidal fissure, and between it heads pass the nasal of the ophthalmic, the third and the sixth nerves.

The four recti form a tendinous expansion quarter of an inch from the margin of the cornea and continued forward to it, called Tunica Albuginea. The inferior oblique, which arises from the inferior margin of the orbit, is inserted opposite the superior oblique into the outer and back part of the eyeball. The arteries that supply the recti muscles send forward minute straight converging branches, called the Anterior Ciliary through the sclerotic, and it is by the enlargement of these that the vascular zone, so characteristic of *sclerotitis*, is produced. Dull aching pain and fever are the only other symptoms of this affection.

The surface of the conjunctiva is constantly moistened by the lachrymal gland that pours its secretion by many openings on the upper and outer part of the conjunctiva, so that it becomes diffused over the whole surface. The lachrymal nerve supplies this gland, and then terminates in the upper eyelid. The nasal nerve, as it crosses above the optic nerve, supplies the long ciliary nerves, having previously given the long upper root to the ciliary ganglion. The ophthalmic artery gives off lachrymal, nasal, supra-orbital, frontal and palpebral, long and short ciliary, centralis retinæ, and muscular: a branch, in fact, to all the structures in the orbit.

The iris consists of circular muscular fibres that surround the pupil, of elastic fibres that radiate from these, of pigment cells, partly scattered among the fibres and giving the characteristic colour to the iris, partly collected on its posterior surface as a deep purple layer, called Uvea, which prevents the transmission of light. The lining membrane of the aqueous humour is best seen on the posterior surface of the cornea, which constitutes with the iris the anterior chamber of the eye.

Diseases of the Eyeball.—Opacity of the cornea is called *nebula* when caused by a film of lymph between the cornea and its conjunctival investment—*albugo*, when the result of lymph or pus between the layers of the cornea itself, and *leucoma* when caused by the cicatrix of an ulcer.

Iritis is characterized by change in the colour of the iris and contraction of the pupil. If the inflammation be very intense, then lymph may be exuded on the surface of the iris, forming little patches, and perhaps filling up the aperture of the pupil, so causing spurious cataract; and in this contracted state the iris very likely adheres to the lens. The aqueous humour is turbid, and the iris may be turned brick red or greenish brown, according as the original colour was grey or blue —the reddish yellow colour of the injected capillaries shining through the blue-coloured iris will obviously produce green. *Conjunctivitis*, characterized by the tortuosity and superficiality of the vessels, and *sclerotitis*, marked by the depth and straightness of the injected anterior ciliary arteries that form a zone around the cornea, generally attend the severer attacks of iritis—and so indeed may constitutional fever also. The intense pain shooting from before backwards, often with pain of head, is not peculiar to this affection. In regard to treatment, calomel and opium may be given after blood-letting so as just to affect the gums very slightly; it is not at all necessary to cause salivation. But if the patient has syphilis, then it is generally agreed that turpentine in drachm doses may be a good substitute. Some say it is good, others deny that it has any effect. The patient should, at all events, be kept very quiet, and the pupil should be dilated with solution of belladonna dropped into the eye, or with its extract rubbed on the eyelids. If the iris should adhere to the lens, there can be no question that it is better for it to adhere with the pupil in an open than in a closed state. In the syphilitic form, attention to the constitutional symptoms is of the greatest importance; perhaps iodide of potassium may be useful. Local bleeding by leeches, and counter-irritation by blisters, behind the ears, may assist.

Retinitis is characterised by flashes of light before the eyes, gradually increasing dimness of vision, and finally, blindness: there are also intense pain shooting from before backwards with pyrexia. Exposure to a bright light, and also to cold and moisture, may bring on this inflammation; and as the same sort of causes also produce sclerotitis, &c., there is a great likelihood that some of these may accompany the retinitis. General blood-letting, followed by calomel and opium, of course are the remedies, which, along with the antiphlogistic diet, and seclusion from light, may be expected to afford relief.

Amaurosis is partial blindness arising from chronic inflammation of the retina, or from the pressure of a tumour on the optic nerve, or from disease in the brain itself, or from some other cause by no means obvious. The patient has a vacant stare, and sees best in a bright light. Sometimes there is a deep-seated green colour in the vitreous humour; in this case, the disease is called *Glaucoma.* As strychnia has the credit of being a good stimulant of the cerebro-spinal system of nerves, it has been used pretty often, but without almost any success. The dose is 1-16th of a grain, and whenever the limbs begin to twitch, the doses must be lessened.

Cataract is an opacity of the lens, of its capsule, or of both. This disease, which is perhaps the result of degeneration, presents three degrees of consistence, being hard in old people, soft in young persons, and milky in children. The hard may be extracted, the soft cut up, and the milky punctured. Recollecting the position of the iris, it is obvious that the cornea may be separated from the sclerotic without injuring the iris.

The operation of extraction consists first in cutting through the upper half of the circumference of the cornea near its attachment to the sclerotic, and having thus gained admission into the anterior chamber of the eye, the anterior portion of the capsule of the lens is to be lacerated by a needle introduced through the pupil. When gentle pressure is now made upon the eyeball, the lens very likely escapes, and then the operation is successful; but the vitreous humour may also escape, and then the eye is lost.

But a needle may be pushed behind the iris, and the lens may be cut up, or pushed back into the vitreous humour, or removed from the axis of vision, by being turned over on its side. This last operation is called *reclination.*

True cataract is easily known from false by the dimness being behind the iris, and having the shadow of the iris surrounding it; but false cataract is merely a film of lymph occupying the pupil. Though a cataract may appear to be dark-brown, white, &c., yet when the lens is extracted, it is not darker than amber or bluish-white, and is always semi-transparent. As the opacity commences in the centre of the lens, cataractic patients generally see best in the twilight, when the pupil is dilated, and they are altogether remarkably inquisitive looking persons. According to the position of the opacity, a striated or spotted appearance may be observed.

Staphyloma is the projection of the cornea between the eyelids, and as in such a case, the utility of the eye is already lost, the protruded part may be cut off.

Hypopion is an accumulation of purulent matter between the iris and cornea, and though the patient move his head from side to side, yet the surface of the fluid in the anterior chamber always maintains the same level.

Onyx consists of pus between the layers of the cornea at its lower part.

Meatuses of the Nose.—The upper, the middle, and the lower meatuses of the nose, lie immediately under the corresponding turbinated bones: the upper two of course belonging to the ethmoid, the lower being distinct. The upper meatus communicates by the posterior ethmoid cells with the sphenoidal sinus, and a groove leads from it directly into the spheno-palatine foramen. The middle meatus communicates by the anterior ethmoid cells with the frontal sinuses, and, by means of an aperture in the upper maxillary bone with the antrum highmorianum, which excavates that bone. The lachrymo-nasal canal communicates with the lower meatus, and the eustachian tubes lie opposite its posterior aperture in such a manner that a probe might be passed into them from the meatus.

Nasal Polypi.—It is sometimes impossible to remove the whole of a mucous polypus at once, for the meatus is narrow, and will not easily admit even small forceps: but when one part is removed, then the portion that lies higher up in the fossa expands and comes within reach. The fibrous polypus is often firmly attached to th periosteum, and may cause a good deal of hæmorr hage by its removal. Medullary polypus i when fully developed, a cancerous growth, and i of course, irremediable : relief may be given som times by clearing the nostrils from time to time.

The Temporal Fossa contains the tempor muscle, with the arteries and nerves which suppl it. The ridge that lies on the frontal, pariet and temporal bones, form its upper boundary ; th zygomatic arch and the ridge on the great win of the sphenoid constitute its lower boundar As the muscle arises not only from the surface the fossa itself, but also from the deep surface the thick fascia that invests it, the fibres converg to form a twisted tendon that is inserted into th coronoid process of the lower jaw, and down it inner side as far as the mylohyoid ridge. Th masseter muscle arises from the lower border the malar bone and zygomatic arch, as far bac nearly as the tubercle ; the anterior fibres li superficial, and are inserted into the angle an ramus of the jaw ; the posterior lie partly unde cover of these, and are inserted into the uppe half of the ascending ramus of the jaw. Th internal pterygoid, which arises from the inner surface of the external pterygoid plate, is inserted just opposite to the anterior part of the masseter, and, indeed, is often called the internal masseter. The external pterygoid lies close to the inner surface of the tendon of the temporal muscle. It arises by one head from the ridge on the great wing of the sphenoid, and by another from the outer surface of the external pterygoid plate, and is inserted into the neck of the lower jaw and interarticular fibrous plate of the articulation. It is an interesting fact that the condyle of the lower jaw is always partly dislocated when the mouth is opened, and no doubt the attachment of the external pterygoid to the fibrous plate hinders the condyle from getting dislocated. The *Zygomatic Fossa* contains, besides the external pterygoid muscle, also the internal maxillary artery with its branches, and those of the inferior maxillary nerve.

The Pterygoid Fossa contains merely the origin of the internal pterygoid muscle with that of the circumflexus palati, which is attached to the little scaphoid fossa at the upper part of its internal plate,—the tendon of the circumflexus is seen turning round the hamular process as it runs to be inserted into the soft palate.

The Spheno-Maxillary Fossa is a recess that lies between the back part of the upper maxillary, the anterior surface of the sphenoid, and the perpendicular plate of the palate bone. The vidian canal and foramen rotundum open on its posterior wall; the spheno-palatine foramen on its inner wall; and the posterior palatine canal extends downwards from it to open on the back part of the hard palate. The superior maxillary nerve crosses the upper part of the fossa; Meckel's ganglion lies against the perpendicular plate of the palate bone, rather below the spheno-palatine foramen, and sends its branches through the apertures which surround it; and, finally, the internal maxillary artery enters the fossa, and divides into the spheno-palatine, pterygo-palatine, and posterior-palatine, the vidian, superior dental, and infra-orbital. Of the branches given off by Meckel's ganglion, the vidian is most remarkable for the extent of its course. Running from before backwards through the root of the pterygoid process, it enters the skull by perforating the plate that fills up the middle lacerated foramen; it then runs along the petrous portion of the temporal bone, and enters the hiatus Fallopii to join with the facial nerve; it takes the course of the facial horizontally backwards, then perpendicularly downwards behind the tympanum; leaving the facial, it enters the back part of that cavity, passes between the handle of the malleus and long process of the incus, leaves the tympanum by the Glasserian fissure, and joining with the gustatory nerve, is conducted by it down to the submaxillary ganglion, in which it terminates.

ANATOMY OF THE NECK.—The upper constrictor arises from the lower half of the internal pterygoid plate, from the posterior border of the pterygo-maxillary ligament, and from the posterior extremity of the mylohyoid ridge, and is inserted with its fellow into a tendinous raphe on the back of the pharynx, and into the basilar process of the occipital bone. The middle constrictor, which arises along the whole length of the greater and lesser cornua of the hyoid bone, just to the inner side of the attachment of the hyoglossus, expands upwards, and overlaps the upper constrictor, but also curves downwards, and is overlapped by the lower constrictor, which arises from the two upper rings of the trachea, from the side of the cricoid and side of the thyroid cartilages. The fibrous tissue of the pharynx extends its whole length, and renders it a continuous bag, which is lined by mucous membrane; but it is not a bag according to the usual signification of the term, but rather a hollow; for the nares, the mouth, and the opening of the larynx, leave scarcely any boundary to it in front. Of the seven openings existing in it, four, namely, the eustachian tube and the posterior nares, communicate with it above the level of the uvula; and three, the mouth, larynx, and œsophagus, communicate with it below the level of the uvula. The same ligament (pterygo-maxillary) that attaches the upper constrictor, also gives origin to part of the buccinator muscle; and although the cheek is in this manner continuous with the pharynx, yet the two pillars of the palate distinctly separate the one from the other. The palato-glossus, which is the anterior pillar, is a bundle of fibres, extending from one side of the soft palate to the same side of the tongue; and the palato-pharyngeus takes the same origin, and is inserted into the posterior border of the thyroid cartilage. Between these two pillars the tonsil is placed, with its outer surface lying in contact with the upper constrictor; and the mucous membrane of the pharynx being continuous with the lining of the mouth, folds around the projections of these pillars of the palate, and is continuous of course with the elementary structure of the tonsil.

There are obviously no parts within the pharynx that it would be dangerous to meddle with; although, of course, tickling of the fauces would cause nausea and vomiting, and the deposition of a solid body within the pharynx would cause swallowing. But it is important to remember, that the mechanism of deglutition would entirely prevent any gargle from reaching an ulcer situated upon the back part of the pharynx, and that the only way to apply a solution to such an ulcer is to inject it directly. Remembering also how close together the tonsil, the tongue, the epiglottis, and the larynx are placed, great effusion into their submucous tissue may easily obstruct the passage of air along the trachea; and as it is impossible to say exactly how far an inflammation has gone, the only safety in any such case will be in tracheotomy, not laryngotomy.

If the tonsils suppurate, and require to be punctured, then it must be borne in mind, that whenever the knife perforates the upper constrictor, it will most likely enter the internal carotid artery. To guard against this, never more than three-eighths of an inch of cutting edge should be left on the knife used for such a purpose. The back should be turned outwards, the knife driven straight back, and the cut made inwards towards the uvula.

The vessels that lie in contact with the outer surface of the upper constrictor are the internal carotid and jugular, or, more properly, the common sheath which invests them. There is indeed a safe recess for the lodgement of such important vessels, formed by the junction of the rectus anticus major and the upper constrictor. The artery lies nearest the mesial line, the large internal ugular vein being just to its outer side, the pneumogastric, the glossopharyngeal, and the ninth nerves all lying within the sheath; and it is important to remember this; for, with the exception of the lower division of the fifth, which descends between the two pterygoid muscles, these are the only important cerebral nerves that emerge from the base of the skull. It is true that the spinal accessory passes outwards, sometimes in front of the jugular vein, and enters the upper third of the sterno mastoid, but then it is distributed merely to the trapezius, and is only a motor nerve. Of course, there is also the portio dura emerging from the stylo mastoid foramen, and curving forward through the parotid gland to form the pes anserinus on the surface of the external carotid artery, subsequently dividing into temporo-facial and cervico-facial, for the supply of the muscles of expression, which are indeed all belonging to the face, except those of mastication. But then this nerve is purely motor, and cannot compare in importance with the pneumogastric or the fifth.

But to return. A little way from the base of the skull the vein changes its position with regard to the internal carotid, and gets behind it. A glance at the base of the skull will explain the reason of this change; the carotid foramen will be found exactly in front of the jugular; a minute perforation will be observed in the plate that divides them, and this transmits the tympanic nerve of Jacobson, derived from the glosso-pharyngeal nerve, and spreading out into a plexus on the inner-wall of the tympanum. As the sheath of the vessels rests on the rectus anticus major, the superior cervical ganglion of the great sympathetic lies between it and the muscle opposite the second and third cervical vertebræ; and just as the carotid is about to enter its foramen, the two branches from this ganglion which enter the skull form a net-work around it, called the carotid plexus, which, as the artery passes through the cavernous sinus is, for the sake of distinction, called the cavernous plexus. As the jugular vein is emerging from the skull, it rests against the rectus capitis lateralis, and this little muscle, which is attached to the anterior margin of the atloid transverse process, has the vertebral artery emerging from the foramen just behind it.

Tracing the nerves downwards to their distribution, it must first be remarked, that on both sides of the neck the pneumogastric nerve retains its position behind and between the internal jugular vein and its accompanying artery, as far as the root of the neck. A little below the skull, however, the glossopharyngeal leaves the sheath, reaches the lower border of the stylo-pharyngeus muscle, and crossing its outer surface enters the inner and back part of the tongue, forming a nervous circle around the tonsil, and supplying the posterior third, and part of the borders of the tongue, with the sense of bitter taste.

The only branches furnished by the glosso-pharyngeal besides those already mentioned, are one which it contributes to the pharyngeal plexus, and another for the stylo-pharyngeus and upper constrictor.

The ninth leaves the sheath at a lower level in the neck, where the external carotid is more nearly in front of the internal than it is higher up. It hooks round the outer side of the occipital artery close to its origin, and crossing the external carotid, runs along the outer side of the hyoglossus, flattening out as it proceeds, and supplying all the muscles that move the tongue. Just as it is curving round the occipital artery, it gives off a small descending branch that forms a loop, with a small branch derived from the second and third cervical nerves; and this loop is most important, as it often lies superficial to the sheath of the common carotid and internal jugular vein, constitutes a guide to them, and supplies the muscles that depress the hyoid bone, and pull down the larynx. The position of the ninth nerve on the side of the tongue is highly important, for the hyoglossus separates it from the lingual artery, which insinuates itself between this muscle and the middle constrictor of the pharynx. The tortuous course of the artery along the under surface of the tongue under the assumed name of ranine, must not be forgotten, and the branch to the sublingual gland, although small in size, may prove troublesome from hæmorrhage in snipping through the frænum.

Now the space between the rectus anticus, the upper constrictor of the pharynx, and the internal pterygoid, has received the name of maxillo-pharyngeal; and the question now arises, what are the parts besides the fifth that lie between the internal pterygoid and the jaw? The lower maxillary nerve, as it emerges from the foramen ovale, lies to the outer side of the otic ganglion, which usually rests upon the middle meningeal artery, with the eustachian tube to its inner side. The nerve divides into the portion which really resembles a spinal nerve, namely, the mixed sensory and motor portion supplied to the muscles of mastication, and a purely sensory portion which divides into the lingual nerve for the tongue, the inferior dental for the lower jaw, and the anterior auricular, which separating into two, and surrounding the middle meningeal artery, retreats between the internal lateral ligament and the neck of the jaw, and is distributed in front of the ear. The inferior dental, as it enters the foramen, sends on a small branch, which it had conveyed from the posterior division, and which supplies the muscles that depress the lower jaw. The gustatory likewise is joined by the vidian, which emerges from the glasserian fissure, and terminates in the submaxillary ganglion, which lies rather on the surface of the gland, which again occupies the recess between the mylohyoid and the inner side of the ramus of the jaw. This gland is important, for through it is conveyed the facial artery, which may be felt turning over the ramus of the jaw, just in front of the masseter muscle. The gustatory nerve also lies along the outer side of the tongue, and crosses the outer side of the stylo-glossus in its course: it is distributed to the papillæ of the anterior two-thirds of the tongue, and enables that organ to appreciate the varied tastes of sweetness, saltness, &c. As the gustatory and the hypoglossal are both outside the tongue—of course covered by the mucous membrane,—the glossopharyngeal is exactly intermediate between these two. Some consider that the superior laryngeal of the pneumo-gastric, which has a connexion with the pharyngeal plexus, and the vidian nerve, are also nerves of the tongue, and this will increase their number to five.

The internal maxillary artery, which is the principal terminal division of the external carotid, first gets inside the neck of the jaw, and in this convenient position, having the internal lateral ligament to its inner side, it supplies the middle meningeal, the inferior dental, and the anterior tympanic through the fissure in the glenoid cavity. It then curves under the lower border of the external pterygoid, and runs along its outer surface, in that position supplying all the muscles of mastication with blood, and in particular, giving two deep temporal arteries which ramify in the temporal fossa and communicate with the middle temporal artery sent through the fascia by the posterior division of the superficial temporal. Lastly, it passes between the two heads of the external pterygoid muscle, and breaks up into three palatine, the vidian, superior dental, and infra-orbital, and these all lie in the spheno-maxillary fossa. The fossa is, besides, in a great measure occupied by Meckel's ganglion and its branches, and is crossed by the upper maxillary nerve during its transit to the face.

The division of the common carotid takes place nearly opposite the upper border of the thyroid cartilage, and the external is rather to the inner side of the other division, but it then curves upwards towards the angle of the lower jaw, and ascends behind the ramus of that bone, opposite the neck of which it divides into the temporal and internal maxillary.

The ascending pharyngeal artery ascends the pharynx, and supplies one minute meningeal branch through the fibrous plate occupying the foramen lacerum basis cranii, and transmitting the vidian nerve. The superior thyroid artery supplies chiefly the surface of the thyroid gland, but also gives the two laryngeals, the upper of which, with the superior laryngeal nerve, perforates the thyro-hyoid membrane. The lingual artery is the second branch derived from the anterior border of the external carotid, and it and the facial, derived from the same border, often arise together. The branch to the sterno-mastoid, the occipital, and posterior auricular, come off in succession from the posterior border. In the parotid gland, four or five small arteries supply that structure, and a small branch, called the transverse facial, accompanies Steno's duct as it extends forward from the parotid gland to the buccinator muscle, which it perforates obliquely opposite the second molar tooth in the upper jaw. Though this duct has the width of a crow-quill, its aperture will only admit a fine probe. The commencement of the external jugular vein is always superficial to the carotid within the gland, but is sometimes beneath and sometimes above the flattened portio dura.

Now, the only important parts that actually lie across the external carotid are the digastric and stylohyoid muscles and the hypoglossal nerve. All other parts that extend downwards from the styloid process to the jaw, the tongue, the hyoid bone, or the larynx, nay, even the styloid process itself, separate the external carotid from the sheath of the internal.

The sheath of the common carotid, as it ascends in the neck, lies in the recess between the trachea and the longus colli, and against the groove between the trachea and œsophagus ; for it will be remembered that the latter is collapsed from before backwards when food is not passing.

The middle cervical ganglion when present, but always the trunk of the sympathetic, the cardiac nerves, the inferior thyroid artery, and recurrent laryngeal nerve, lie between the sheath and the muscle. The jugular portion of the sheath, indeed, rests partly upon the anterior scalenus, and also perhaps upon the phrenic nerve.

The perfect protection afforded to the vertebral artery as it ascends in the canal formed by the foramina of the transverse processes of the six upper cervical vertebræ, and by the little inter-transverse muscles that lie between them, preserves that artery from injury, except of such a kind as immediately to destroy life. The cervical nerves pass horizontally outwards behind the artery which has its vein in front of it.

The curve that the vertebral artery makes upon the posterior arch of the atlas before it perforates the posterior occipito-altoid ligament, is seen with the nerve emerging from beneath it in the triangle bounded by the two oblique and the great posterior rectus muscles. At the right sterno-clavicular articulation the innominata artery divides into subclavian and carotid, and the most marked features about the subclavian artery, until it reaches the inner border of the anterior muscle, are, that three branches are given off, of which the vertebral is the largest.

The thyroid axis sends off the inferior thyroid to the deep surface of the gland, and also furnishes a supra-scapular, and a transversalis colli which gives off the posterior scapular: it has the phrenic nerve on its outer border, but the pneumogastric on its inner. The internal mammary comes off from the lower border of the subclavian, and the phrenic nerve runs across it to its inner side, just at its commencement.

While behind the anterior scalenus, the superior intercostal artery comes off from the subclavian, and rests against the neck of the first rib; it is intended for the supply of the first two intercostal spaces, and by means of its deep cervical artery, which it sends back under the transverse process of the last cervical vertebra, up the neck, between the semi-spinalis, colli, and complexus, forms an anastomosis with the princeps cervicis of the occipital, thus connecting the external carotid with the subclavian. But there is a much more profuse anastomosis between the latter, and the internal carotid by the circle of Willis, and a less remarkable one between the external and internal carotid by the communication of the nasal of the ophthalmic with the angular branch of the facial.

The larynx consists of a shield-like cartilage (the thyroid) articulated to the sides of a ring-like cartilage (the cricoid), upon the upper and posterior border of which are placed two little cartilages that form something like a pitcher when put together (the arytenoid). Where the cartilages articulate with one another, there are little synovial membranes and capsular ligaments. From the lower part of the receding angle of the thyroid cartilage, where the epiglottis is attached, the two yellow elastic ligaments, called Vocal Cords, extend back to the anterior angle of the base of the arytenoid cartilages. Two little muscles, called Thyro-arytenoid, lie along the outer side of these cords. The rima glottidis, or chink of the glottis, is the narrow triangular space between the vocal cords, or rather between their investments of mucous membrane; and it is effusion into the sub-mucous tissue of their investing membrane that causes nearly all the danger of laryngitis: for as the chink of the glottis is not wider than a third of an inch, a very slight thickening of the mucous membrane would serve to close it, and so prevent the entrance of air altogether. The œdema may not be confined to the glottis, but may affect also the epiglottis, of course making the case worse.

From the upper border of the side of the cricoid, the crico-arytenoideus lateralis muscle extends upwards and backwards to the outer angle of the base of the arytenoid cartilage. The posterior crico-arytenoid arises from the back of the cricoid cartilage, on each side of the raphe, and has the same insertion as the lateral one. The arytenoid muscles consist of transverse fibres running from side to side, and crossing one another obliquely from the back of one arytenoid cartilage to the back of the other.

The crico-thyroid muscle extends from the front of the cricoid to the back part of the lower border of the thyroid. Remembering that the vocal cords are stretched between the thyroid and arytenoid cartilages, then because the crico-thyroid and posterior crico-arytenoid, acting either separately or together, tend to pull these cartilages farther away from one another, it follows that they must be tensors of the vocal cords, and, for the very opposite reason, the other three muscles of the larynx relax the vocal cords. The crico-thyroid is supplied with motion, and the mucous membrane with sensation, by the superior laryngeal nerve. The recurrent laryngeal giving only motor power to the remaining muscles.

The aperture of the larynx, by which it communicates with the pharynx, lies just under the root of the tongue. The epiglottis forms its upper boundary; the upper border of the arytenoid muscle covered by mucous membrane its lower: the two folds of mucous membrane covering the little muscular slips that extend from the tips of the arytenoid cartilages to the sides of the epiglottis, its lateral boundaries. It is important to know, that by pulling forward the tongue with a spatula, the epiglottis may be seen, and caustic may be applied to it when it is enlarged by acute or chronic inflammation.

The crico-thyroid membrane is the position for the performance of *laryngotomy*, but division of it from side to side would scarcely afford much room either for the entrance of air or for the extraction of foreign bodies, and therefore the cricoid cartilage may be cut through from above downwards, and if necessary, a piece taken out of it. Laryngotomy is useful only in cases of foreign bodies lodged in the larynx and in spasm of the glottis, either from asphyxiating gases, from a blow on the larynx, or from causes producing laryngismus stridulus, as before mentioned. Also, when animation is suspended by drowning, the larynx may be opened to insufflate the lungs. In all other cases whatever, where the entrance of air is impeded, trachæotomy must be performed.

Wounds of the throat are worst when they are far down in the neck, for then the great vessels lying close to the trachea are cut through at once. The superior thyroid, the lingual or the facial artery, are most likely to be injured. In a case where a girl cut her throat literally "from ear to ear" with a razor which she succeeded in insinuating even between the cervical vertebræ, the jugular veins only were cut. A glance at the parts in the neck will shew what parts are liable to be cut in attempts at suicide.

Treatment.—The bleeding vessels are to be tied—a stitch or two may be put at each side of the wound if it be a transverse one, but it must not be closed entirely, for the products of inflammation may rapidly accumulate and interrupt respiration. The patient ought to recline, but not lie horizontal. The chin should be bent upon the chest, and if necessary retained there. Two things are of vital consequence, first, to keep the air-tube open; and as inflammation is very likely to occur, tracheotomy must be performed upon the first indication of obstruction to respiration: second, to keep the patient alive by feeding him by means of a tube.

Cases of cut-throat are at the best very dangerous; for the depression of mind leading to, and consequent upon, such catastrophes, is of itself sufficient to prevent a cure.

A blow on the neck may destroy life by producing a shock upon the nervous system; and even continued pressure, that is not sufficient to cause asphyxia, will certainly destroy life.

THE TRIANGLES OF THE NECK.—Taking the lower border of the lower jaw, and an imaginary line from the angle of the jaw to the mastoid process, as an upper boundary; then with this the two bellies of the digastric muscle constitute the submaxillary triangle which contains the submaxillary gland, nicely housed between the mylohyoid muscle and the jaw, the facial artery which ascends through its substance, over the ramus close to the anterior border of the masseter muscle, and the submaxillary ganglion, in which the chorda tympani or vidian nerve terminates. By dissecting deeper into the space, the parts in connection with the tongue come into view, and among others, by dissecting away the mylohyoid, the ninth nerve is found on the side of the hyoglossus, communicating by filaments with the gustatory nerve, which, as it passes forward, crosses Wharton's duct. It is unnecessary to mention that, as in other spaces, cellular tissue and small bloodvessels are freely distributed in this.

The anterior triangle is bounded by the sterno-mastoid muscle behind, the posterior belly of the digastric above, and the upper belly of the omo-hyoid in front. The superior thyroid, with the commencements of the lingual and facial arteries, and the lingual nerve, the sheath of the common carotid artery and internal jugular vein, as also the bifurcation of the common carotid, are the important parts seen in this triangle.

The anterior inferior triangle contains only a piece of the sterno-hyoid and sterno-thyroid muscles.

The posterior superior triangle, bounded by the trapezius, the sterno-mastoid, and the posterior belly of the omo-hyoid muscles, contains in addition to the cervical glands and cellular tissue, the cervical plexus, the spinal accessory nerve, and the transversalis colli artery.

The posterior inferior triangle, which is crossed superficially by the clavicular branches of the cervical plexus, and by the junction of the transversalis colli, transversalis humeri, and external jugular veins, just before these pierce the fascia, contains from below upwards and backwards the subclavian vein, the subclavian artery, and the brachial plexus of nerves: the transversalis humeri artery curves in front of the subclavian artery, and the nerve to the subclavius lies across the subclavian vein on its way to the muscle.

Now, in operating upon the vessels in any of these triangles, it is necessary to remember that the hyoid bone and larynx constitute the unerring guide to the branches of the external carotid, while behind the middle third of the clavicle may be found the subclavian artery, to which the tubercle on the first rib is considered as the proper guide. In cutting down on the carotid and its branches, the anterior border of the sterno-mastoid is the line of direction for the incision; but in cutting into the subclavian, the skin is generally pulled down over the clavicle, and incised upon that bone; so that when it resiles, the external incision is found lying opposite to the fascia investing the triangle. Unless great care be taken, the operator may have good reason to remember that blood enters the chest easiest during inspiration; for if the great veins in the neck be punctured, then the next full inspiration that the patient takes will likely be his last. The blood rushes into the chest; but unfortunately the air follows it, and mixing with the blood in the right ventricle of the heart, causes it to froth up, and the heart is paralyzed. The occurrence of this accident is marked by a crimson colour suffusing the countenance, followed by syncope. The prevention of this accident may be ensured by wrapping a bandage tightly round the patient's chest.

If the needle be passed from above downwards round the artery, the brachial plexus will not be so much in danger; and although the general rule in passing a needle round an artery is to keep its convexity towards the accompanying vein, yet in the case of the subclavian the vein is not in the way.

THE AXILLARY SPACE has its apex above, either between the two scaleni opposite the outer border of the first rib, where the subclavian terminates (this is its natural boundary), or at the triangular space, bounded by the first rib, the clavicle, and the upper border of the scapula. The posterior wall is formed by the subscapularis, latissimus dorsi and teres major muscles, and upon these in that order rests the axillary artery, separated, however, by the brachial plexus of nerves. The pectoralis major and minor form the anterior wall; but the pectoralis minor covers only that part of the space corresponding to the coracoid process of the scapula; and as the brachial plexus surrounds the artery to the thoracic side of this process, the pectoralis minor covers that division of the artery that cannot be ligatured. The outer wall is, properly speaking, a recess formed by the meeting of the posterior with the anterior walls, in which lies the coraco-brachialis and a little bit of the humerus. The three upper ribs constitute the inner wall. The brachial plexus, as already stated, lies external to and behind the upper third of the artery, surrounds it closely in its middle third, and has its branches placed on either side, and behind the lower third. The axillary vein, which is formed by the junction of the venæ comites of the humeral with the basilic, lies to the inner side of the artery, and receives veins that correspond, in a general way, with the branches of the artery. It must not be forgotten that the cephalic vein, which, with the descending branch of the acromial thoracic artery, lies in the cellular interval between the deltoid and pectoralis major muscles, does not enter the axillary vein, but crossing in front of it, passes below the clavicle, and empties itself into the subclavian. The short thoracic artery arises from the axillary above the upper border of the pectoralis minor, and runs between the pectorals and supplies them. It often arises along with the acromial thoracic, which is a very constant branch, and comes forward quite close to the upper border of the lesser pectoral, dividing into a thoracic branch for the supply of the muscles, and an acromial, which sends down the branch between the deltoid and great pectoral. The acromial thoracic supplies part of the shoulder joint, communicates with the supra-scapular on the acromion process, and thereby establishes an anastomosis, important in case of the subclavian being tied. Behind the small pectoral, a branch is sent off to the axillary glands, and at its lower border the long thoracic comes off either as a separate branch or in conjunction with the subscapular, which is close beside it. The two circumflex arteries arise a little below the subscapular, the anterior supplying a branch to the shoulder-joint which runs up along the tendon of the biceps: the posterior curves back with the circumflex nerve round the neck of the humerus, through the quadrilateral space included between the two teres muscles, the long head of the triceps, and the humerus.

The most important fact, perhaps, in regard to the axillary artery is, that it rests but slightly on the chest,—merely on the first serration of the serratus, and first intercostal, and then immediately lies close to the humerus, keeping to the inner border of the coraco-brachialis. Hence it is that all incisions made into the axilla for the purpose of evacuating abscesses, are made with the knife directed towards the chest, not towards the arm. From the outer cord of the brachial plexus, the external cutaneous nerve is given off into the substance of the coraco-brachialis through which it passes, and then rests upon the brachialis anticus covered by the biceps. The outer anterior thoracic, and the outer head of the median nerve, come off from the same cord. The inner head of the median, the ulnar, the internal cutaneous, the lesser internal cutaneous of Wrisberg, and the inner anterior thoracic, all come off from the inner cord. The ulnar reaches the space between the internal condyle and the olecranon process, by piercing the internal intermuscular septum with the inferior profunda artery. The internal cutaneous perforates the fascia on the inner side of the arm, about half way down, and lies in front of the elbow, and the nerve of Wrisberg reaches no farther than the elbow. The median nerve, which arises from the outer and inner cords of the plexus, first embraces and then lies to the outer side of the axillary artery: it crosses the humeral artery half way down the arm, and then lies to its inner side, about two inches above the elbow.

The circumflex, musculo-spiral, and three subscapular nerves, come off from the posterior cord. The circumflex supplies the deltoid, and, assisted by the supra-scapular, supplies the shoulder-joint also. The musculo-spiral, attended by the superior profunda artery, extends to the front of the outer condyle of the humerus, lying first in the spiral groove of the humerus under cover of the triceps muscle, and then in the groove between the supinator longus and brachialis anticus muscles. The highest subscapular nerve supplies the subscapularis muscle, the lower supplies the subscapularis and teres major, while the long subscapular terminates in the latissimus dorsi.

The axillary glands and cellular tissue fill up the rest of the conical space. The fascia, stretching from the lower border of the great pectoral to the lower border of the teres major, which is on a lower level, forms the inferior boundary of the axilla.

The sheath of the humeral artery, as it extends downwards, lies in front of the long head of the triceps, upon the inner head, with the coraco-brachialis to its outer border. Then, crossing over the insertion of the coraco-brachialis, it rests on the brachialis anticus, having now the biceps to its outer border. Lastly, it rests on the tendon of that muscle; and one finger's-breadth below the bend of the elbow divides into the radial and ulnar. The sheath containing the radial rests in succession upon the supinator brevis, the pronator teres, the flexor sublimis, the flexor proprius pollicis, and the pronator quadratus: then crossing the external lateral ligament of the wrist, under cover of the two first extensors of the thumb, it enters the palm of the hand between the two heads of the first dorsal interosseous muscle, under cover of the third extensor of the thumb; and crossing the metacarpal bones and their muscles, about half an inch from their bases, it joins with the communicating branch of the ulnar, and forms the deep palmar arch.

The ulnar artery curves inwards between the humeral and coronoid origins of the flexor sublimis, separated from the median nerve by a portion of the pronator teres, and then rests upon the flexor sublimis clear down to the wrist joint, with the ulnar nerve to its inner side for its lower two-thirds. The continuation of the artery crosses the hand opposite the first joint of the thumb, and communicates with a small artery emerging from the muscles of the thumb to form the superficial palmar arch. Both the nerve and the artery send a deep branch beneath all the muscles, between the adductor and abductor minimi digiti.

The sheath of the humeral contains the venæ comites, and perhaps also the median nerve, which, lying to its outer side above, crosses it about the middle, and gets to its inner side. The basilic vein lies superficial to the thick fascia of the arm, but over the situation of the artery; it perforates the fascia about the middle of the arm, and gets quite close to the sheath.

Bend of the Elbow.—There is no proper space at the elbow, but the parts lying between the supinator longus on the outside, and the pronator teres on the inner side, are highly important. The brachialis anticus occupies the space between these two muscles, and is inserted into the coronoid process of the ulna; the biceps in a great measure covers the brachialis, and its tendon comes down through the centre of the space.

As the musculo-spiral nerve divides opposite the outer condyle into posterior interosseous, perforating the supinator brevis, and radial, which lies under the supinator longus, only part of that nerve is in the space. The sheath containing the humeral artery, as it rests upon the tendon of the biceps, has the median nerve to its inner side, and is held down by a firm semilunar band of white fibres, sent off from the tendon of the biceps towards the inner condyle of the humerus, to thicken the fascia of the forearm, which stretches across and binds down the parts now mentioned.

Of the three veins that ascend to the elbow, the median divides into two, one joining the radial to form the cephalic vein, the other joining the ulnar, forming the basilic. The external cutaneous nerve pierces the fascia at the outer border of the biceps, and crosses the median cephalic vein; then dividing into an anterior and posterior branch, supplies the forearm as far as the wrist, sending a small branch upon the radial artery. The internal cutaneous nerve crosses the median basilic, and extends as an anterior and posterior branch, to the inner border of the forearm as far as the wrist. Two lymphatic glands rest over the course of the artery at the bend of the elbow. The venæ comites of the radial and ulnar join to form the venæ comites of the brachial, and communication through the fascia takes place between the deep and superficial veins.

The ligature of the humeral at the bend of the elbow is very difficult. The median basilic vein is the most convenient to bleed, because it lies over the semilunar fascia, and, consequently, pressure can be applied to it. The median cephalic, on the contrary, when pressed upon, recedes into the angle between the supinator longus and pronator teres. When the artery is punctured, then there may be formed a false aneurism, a varicose aneurism, or an aneurismal varix. The first of these is the distention of cellular tissue by blood; the second is the communication of the artery with the vein by means of a sac; and the third is the direct communication between the artery and the vein. In all these cases pressure is to be tried first; if that fail, then the sac is to be cut into, the clot turned out, and the artery tied above and below its punctured part.

The anterior annular ligament extends from the unciform process of the unciform bone and the pisiform bone to the ridge on the trapezium, and to an eminence on the scaphoid: it binds down the flexor profundus digitorum, the flexor proprius pollicis, the flexor sublimis, the flexor carpi radialis, and the median nerve. Of course, the ulnar artery and nerve do not pass under the ligament, neither do the tendon of the palmaris longus, nor the palmar cutaneous branch of the median, nor the superficialis volæ artery.

Upon the flexor profundus in its course down the arm, rest the median nerve, with the ulnar artery and nerve. The anterior interosseous artery and nerve rest upon the membrane, under cover of the flexor of the thumb and deep flexor of the fingers; but the posterior vessels of the same name lie between the two layers of extensor muscles. On the back of the wrist, beginning at the tubercle, at the base of the styloid process of the radius, there is first the supinator longus, then the extensor of the metacarpal bone, and of the first phalanx of the thumb in the same groove; then the long and short extensor of the radial side of the carpus; then the extensor of the second phalanx of the thumb; then the extensor of the index finger; then the common extensor of the fingers ; lastly, the extensor of the ulnar side of the carpus. The muscles of the hand are divided into those of the thumb, those of the little finger, the interossei and lumbricales.

The musculo-spiral nerve, besides giving off cutaneous branches, supplies every muscle of the upper arm and forearm that has the function either of extension or supination : a separate enumeration is uncalled for if this rule be remembered. The posterior interosseous branch of it, after passing between the layers of muscles on the back part of the forearm, supplies the back part of the wrist joint.

In the forearm the median nerve supplies both pronators, and every flexor of the forearm, except the flexor carpi ulnaris and the inner half of the flexor profundus digitorum ; these last are supplied by the ulnar nerve, which, besides giving branches to the elbow and wrist joints, supplies all the muscles of the hand except the abductor and flexor ossis metacarpi Pollicis, one head of the flexor brevis Pollicis, and the two outer lumbricales muscles which are supplied by the palmar portion of the median.

The Shoulder Joint is protected by the coraco-acromial ligament which arches over it. The coraco-humeral extends from the under and anterior part of the coracoid process to the great tuberosity for retaining the long tendon of the biceps in its place. The capsular ligament, rather loose, surrounds the margins of the glenoid cavity and of the anatomical neck of the humerus, but is imperfect in two situations, namely, where it sends down a pouch of synovial membrane around the tendon of the biceps, and where it protrudes another little pouch under the tendon of the subscapularis. The glenoid ligament deepens the glenoid cavity, and appears to be continuous with the tendon of the biceps at the upper margin of that cavity. But the cartilage is thickest on the margins of the cavity, and on the centre of the head of the humerus, the other parts being thin.

The muscles surrounding the shoulder joint are the supra spinatus, infra spinatus, and teres minor behind and above, the subscapularis in front, the long tendon of the biceps above, the long head of the triceps below. The deltoid forms a general covering for these.

The nerves to the joint are the suprascapular and circumflex. The arteries are of the same names as the nerves, with the addition of the acromoi-thoracic.

When the muscles are cut from around the shoulder joint the humerus separates from the glenoid cavity.

Elbow-joint.—The ligaments of the elbow-joint are the external lateral, extending from the lower part of the external condyle to the orbicular ligament surrounding the head of the radius, and to the extremities of the lesser sigmoid cavity. The internal lateral extends from the lower part of the condyle to the inner margin of the great sigmoid cavity, spreading out like a fan. The anterior and posterior ligaments are attached to the coronoid and olecranon processes, and above and around the margin of the corresponding fossæ in the humerus. These ligaments are continuous with one another.

The ulnar nerve on the inner side, and the musculo-cutaneous on the outer side, supply the elbow-joint.

All the branches of the humeral, except the muscular and nutritious, and all the recurrent branches from the forearm, supply this joint.

The Wrist.—The ligaments of the wrist are the external lateral, extending from the styloid process of the radius to the tuberosity of the scaphoid bone; the internal from the styloid process of the ulna to the cuneiform bone; the anterior, extending between the borders of the radius and ulna above and the first row of carpal bones, except the pisiform below; the posterior taking the same position on the posterior surface of these bones: the ulnar and musculo-spiral nerves supply this joint.

Along the margins of the fingers the arteries lie with their nerves superficial to them. The arteries form a loop upon the last phalanx of each finger, whereas the nerves divide into two branches, one to the pulp of each finger, the other to the parts about the root of the nail.

Hœmorrhage from the palmar arches is to be treated by graduated compress, for even ligature of the humeral has failed to stop such hæmorrhage.

THE THORAX.—The first dorsal vertebra, the first rib, and the sternum, bound the inlet of the thorax. Through it pass the sterno-hyoid and sterno-thyroid muscles from the first bone of the sternum, the longus colli covering the anterior surface of the upper dorsal vertebræ; the trachea, with the æsophagus behind it, lies in the mesial line, the great vessels clinging as it were to the side of it for support. The great vessels of the neck ascend on each side of the trachea ; and as it widens out into the larynx the distance between the vessels increases. The thoracic duct lies to the left side of the æsophagus, then curves downwards and outwards, crossing the vertebral artery, thyroid axis, phrenic nerve, and anterior scalenus. The innominata artery emerges from the cavity on the right side of the trachea ; the left carotid and left subclavian emerge on its left ; and the two innominata veins, with numerous branches from the thyroid gland, enter the chest. The first dorsal nerve ascends to join the brachial plexus ; the phrenic, the pneumogastric, and the great sympathetic enter the cavity, and so also do the internal mammary and superior intercostal branches of the subclavian artery. The left recurrent laryngeal nerve only emerges from the chest. Whatever space at the inlet of the thorax remains unoccupied by the lungs, and by the parts now mentioned, is closed by the cervical fascia, which at once retains the parts in their proper position, and prevents atmospheric pressure from interfering with the transit of blood along the great vessels during inspiration.

The apices of the lungs covered by pleura project above the margins of the first ribs, and fill up a great part of the inlet of the thorax on each side of the mesial line.

The wall of the thorax is constituted by the sternum and dorsal vertebræ, ribs, and intercostal muscles. The external intercostals commence behind at the tubercles; their fibres run downwards and inwards as far as the cartilages, and they are continued forward to the sternum by membrane. On the contrary, the internal intercostals commence at the sternum, their fibres crossing the direction of those of the external; they cease to be muscular at the angles of the ribs, and are continued back to the vertebræ by membrane. Between these layers lie the intercostal vein, artery, and nerve in the order named, from above downwards. But it is only the vein that is protected by the grooved border of the rib; and although the artery appears to lie in much danger from punctured wounds, yet experience has shewn that it is not very liable to be injured. Midway between the vertebræ and sternum, each intercostal nerve gives off a branch which perforates the intercostal muscle, is called the Lateral Cutaneous Nerve of the Chest, and divides into an anterior and posterior branch.

The six upper intercostals pierce the fascia on each side of the sternum. The lower six, which have run forward between the layers of the abdominal muscles, pierce close to the mesial line, and like the upper ones, run back to supply the skin. The direction of the fibres of the intercostal muscles exactly corresponds with that of the external and internal oblique muscles of the abdomen. The muscles that clothe the thorax are the pectorals, serrati, external oblique, and latissimus dorsi; the subclavius also assists.

The Mammary Gland lies upon the pectoral muscle, inclosed between the two layers of the superficial fascia of the thorax. It is hemispherical in form, extends from the third to the sixth or seventh rib, and from the border of the sternum to that of the axilla. The nipple projects from the centre of the gland, and is rather more than half an inch in length. Its apex presents a slight reddish depression, into which open the minute apertures of the gland ducts. The nipple is surrounded by the areola, which is about an inch in diameter, and its surface as well as that of the nipple is studded over with little tubercles, into which the sebaceous, as well as more complex follicles pour their secretions. The depth of colour exhibited by the areola is remarkably affected by menstruation, pregnancy, and lactation.

The gland consists of about twenty lobes of a reddish-white colour, and these are united to one another, and bound to the skin and to the deep fascia, by septa, formed of cellular and adipose tissue. But it is to be remarked that there is no fat within the lobes. Each lobe consists of numerous lobules, and each lobule consists of several clusters of vesicular pouches, each cluster surrounding the commencement of an ultimate gland duct. Several terminal ducts unite to form one lobular duct, and the several lobular ducts are united into a single duct, which conveys the secretion from an entire lobe. The constituents of each lobe are held together by areolar tissue, and the twenty ducts derived from the twenty lobes, converge to the areola, under which they become dilated into pouches, one-sixth to one third of an inch in diameter; then becoming contracted in width, they ascend parallel to one another, and open on the apex of the nipple.

A venous plexus covers the gland just under the skin, and a lymphatic plexus lies on both its superficial and deep surfaces. The arteries of the nipple run side by side from its base to its apex, communicating with one another by lateral branches. A venous plexus, similarly arranged, lies in the intervals of the arterial one, and these two plexuses constitute the erectile structure of the nipple. Branches of the internal mammary, and of the axillary vessels, supply the gland.

Diseases of the Mamma.—Considering how the cellular tissue dips into and splits up the mammary gland, it is not wonderful that mammary abscess should be so troublesome, and that sinuses should be so apt to form throughout its substance. There is no doubt, in the majority of instances, that mammary abscess, the result of inflammation in the cellular tissue of that organ, occurs from neglect of the great rule, that the child ought always to be put to the breast immediately after delivery. For although the mammary secretion at this period has not assumed its true character, yet it may well serve as an aperient highly suitable for removing effete matter from the intestinal canal.

Tumours in the mamma may be either simple or cystic, and may as well be removed, unless of very trifling size.

Cancer of the mamma, however, need not be meddled with, if the lymphatic glands of the axilla are enlarged and hard. In operating on the mamma, a sufficient amount of the skin should be removed, to prevent redundancy when the edges of the wound are brought together; and in this, as in other cases, where the lips of an extensive wound are to be nicely approximated, after the bleeding vessels have been tied, and the sutures passed through the lips of the wound, a piece of wetted lint should be interposed until the hæmorrhage has stopped and lymph has glazed the entire surface of the wound. The edges are then brought together, and union by the first intention is the result.

As the nipple generally requires to be removed, the lower incision, with its convexity downwards, should be made first; for, if not, the blood from the upper incision, by trickling down, will prevent the surgeon seeing to make the under one correctly.

As the diaphragm is a moveable septum, the more the thoracic cavity is increased by its descent, the more will the abdominal viscera be pressed upon and displaced. As a septum, it ought to be attached entirely around the outlet of the thorax; but as the quadratus lumborum arises from nearly all the anterior surface of the last rib, and as the psoas magnus arises from the side of the body of the last dorsal and four upper lumbar vertebræ, it is quite evident that the diaphragm cannot get an attachment to bone for its entire circumference. But the fascia that invests the quadratus and psoas is quite strong enough to give origin to muscular fibres; and the thickened part of it, to which the diaphragm is attached, is called Ligamentum Arcuatum Externum, upon the quadratus, and ligamentum arcuatum internum upon the psoas.

The right crus arises from the second, third, and fourth lumbar vertebræ, the left from the second and third only. Between these crura the aorta enters the abdomen under a tendinous arch, which gives origin to fibres continuous with the crura; and with it, through the same aperture, pass the thoracic duct and vena azygos major. The right crus crossing over the left, and then again joining with it, constitutes the œsophageal opening which lies just in front of the aorta, and transmits the œsophagus with the left pneumo-gastric nerve in front, and the right behind it. The diaphragm takes attachment from the tip of the last rib, and from the inner surfaces of all but the upper six, indigitating with the transversalis abdominis. All the muscular fibres are inserted into the cordiform tendinous centre, in which lies the aperture for the inferior cava. The thoracic duct lies close to the right border of the aorta, and separates that vessel from the vena azygos major. The great and small splanchnic nerves pass through the crura. The lesser vena azygos passes through the left crus, and so enters the chest.

The phrenic arteries, from the abdominal aorta, ascend on the under surface of the diaphragm, and divide into anterior and posterior branches for its supply.

Contents of the Thorax.—The lungs, the heart, with the membranes which invest these and permit of their easy motion, occupy the greater part of the cavity. The base of the heart corresponds with the right side of the bodies of the fifth, sixth, and seventh dorsal vertebræ, its apex with the fifth intercostal space about two inches and a half to the left side of the base of the ensiform cartilage; and the chest is duller on percussion for a space of about two inches from above downwards, and from side to side to the left border of the lower part of the sternum. It is here that the heart is least covered by lung.

As the mitral valve lies at the base of the left ventricle, any sound of regurgitation will be heard best below the nipple, which corresponds with the fourth rib. The aorta arises from the left ventricle of the heart, just behind the upper border of the fourth sterno-costal articulation of the left side, and over this spot, therefore, disease of the aortic valves may be detected by auscultation. As the heart is a flattened cone with its posterior surface resting upon the diaphragm, it is obvious that the movements of respiration will considerably affect the intensity of the cardiac impulse. This will evidently be greatest in forced expiration, and of course the reverse in full inspiration.

The aorta ascends behind the sternum as high as the upper edge of the junction of the cartilage of the second rib with the right side of the sternum. It then arches backwards to the left side of the body of the second dorsal vertebra, and descending to the lower border of the third, it completes the arch. At its commencement the upper part of the dilatations called sinuses of Valsalva give off the coronary arteries, the left of which lies in the groove on the front of the heart, sending a branch along the left auriculo-ventricular groove; the right one turns to the back of the heart in the right auriculo-ventricular groove, and then descends between the ventricles. The pericardium invests the great vessels that arise from the heart, and becomes continuous with the thoracic fascia about an inch and a quarter below the upper border of the sternum. As the œsophagus lies behind the trachea, and a little to its left side, after the arch of the aorta rests against the bifurcation of the trachea, it then touches the œsophagus and thoracic duct. The innominata, left carotid, and left subclavian, arise from the upper border of the arch, and the left innominata vein crosses these great vessels from left to right. The phrenic nerve crosses the arch to the left side of the origin of the subclavian artery; the pneumogastric crosses it between the origins of the subclavian and carotid. Cardiac branches also lie on the arch. A few bronchial glands occupy the space under the bifurcation of the trachea, while the left bronchial tube and the right pulmonary artery lie under the arch itself. The pulmonary artery lies in front, and then to the left side of the ascending aorta. The superior cava and right auricular appendix lie to its right border. The root of the lung is constituted by a bronchial tube, a pulmonary artery, two pulmonary veins, with bronchial arteries and veins, lymphatic vessels, cellular tissue, and an anterior and posterior pulmonary plexus of nerves from the pneumogastric and sympathetic.

The pulmonary veins lie lowest and most anteriorly on both sides: the right bronchial tube lies above and behind; the left one below and behind its corresponding pulmonary artery. The bronchial arteries lies along the posterior surface of each tube: there are usually two on one side, and one on the other.

The pneumogastric nerve, in its course down the neck, gives off a branch to the pharyngeal plexus, a superior laryngeal, and cardiac branches; and on the right side crosses over, and sends the recurrent laryngeal behind, the subclavian artery. But on the left side this nerve curves under and behind the arch of the aorta: afterwards, however, taking the same course as the right recurrent nerve.

The right pneumogastric, passing backwards, rests upon the posterior surface of the œsophagus; and the left one having crossed the arch, descends behind the root of the lung and rests upon the front of the œsophagus as far down as the stomach. The anterior and posterior pulmonary, the œsophageal, and the gastric plexuses, are formed as the nerves descend.

The phrenic nerve is derived from the third, fourth, and fifth cervical nerves. It crosses the anterior scalenus muscle, lying obliquely under the transversalis colli and humeri arteries, and enters the chest between the subclavian artery and vein, crossing obliquely the origin of the internal mammary. On the left side also, it crosses the aortic arch, and on both sides it rests upon the root of the lung. The left nerve is longer than the right, because it lies along the left border of the heart. The right nerve, lying to the right border of the superior cava, takes a shorter course to the diaphragm.

The Posterior Mediastinum, which lies between the vertebræ, the pleuræ, and the pericardium, has the longus colli within its upper part, the psoas magnus in its lower. The trachea, down to its bifurcation opposite the third dorsal vertebra, the œsophagus passing through the diaphragm opposite the tenth, the thoracic duct lying, first to the right border of the aorta, and then behind the aortic arch, and lastly, the thoracic aorta itself, all lie within the posterior mediastinum. The great vena azygos returning nearly all the blood from the right wall of the chest, and also from the bronchial vein, arches above the root of the right lung to enter the superior cava. The superior intercostal vein of the left side, which opens into the innominata, receives the blood from the upper intercostal veins, and the lesser vena azygos which communicates with it and with the great azygos vein, receives the blood from the lower intercostals; but both azygos veins commence in the upper lumbar veins of their own side.

The bronchial tubes consist of a double layer of longitudinal fibres, held open by incomplete cartilaginous rings placed transversely between the layers. These rings are completed behind by transverse muscular fibres, which also exist along the posterior part of the tube in the spaces corresponding to the intervals between the rings. The bronchial tubes divide dichotomously, that is to say, each tube always divides into two; and this rule holds good with respect to all except the very minute tubes, the exact arrangement of which it is difficult to ascertain. The smaller bronchial tubes, instead of cartilaginous rings regularly arranged, appear to have these divided into smaller segments, and distributed around the tube. As the tubes diminish, the circular fibres gradually take the place of the cartilage, and the terminal bronchial tubes (1·50th to 1·30th of an inch), have merely circular and longitudinal fibres. Each tube terminates in a number of sacculations, which communicate with one another only by the tube to which they belong. These air cells are polyhedral in the deep parts of the lung, but larger and nearly globular towards its surface, and especially towards the apex. The lobules are bound together by areolar tissue and serous membrane, into three lobes on the right side and two on the left.

As the thoracic aorta descends towards the diaphragm, it rests upon the left side of the bodies of the dorsal vertebræ, and upon the lesser vena azygos. The pleura lies upon its left side; the thoracic duct keeps close to its right border. The œsophagus, which comes forward under the bifurcation of the trachea, lies first to its right border, and then in front of it. Of course, the root of the left lung crosses the aorta above, and just below that lies the pericardium. The great and the small splanchnic nerves lie close upon the vertebræ.

Between the sternum, the pleuræ, and the pericardium, lies *the anterior mediastinum* pulled rather to the left side by the position of the heart; and therefore containing the left internal mammary artery and veins. Cellular tissue, the remains of the thymus gland, a few lymphatics from the liver, with the origins of the sterno-hyoid, sterno-thyroid, and triangularis sterni, complete the contents.

The internal mammary artery lies between the pleura and triangularis sterni behind, and the costal cartilages and intercostal nerves in front: it is parallel to and about half an inch from the border of the sternum. Between the sixth and seventh ribs it divides into the musculo-phrenic, which runs along the attachment of the diaphragm, and anastomoses with the phrenic from the abdominal aorta, and the superior epigastric, which enters the upper part of the rectus and anastomoses with the deep epigastric from the external iliac.

Punctured wounds of the Chest are generally made with a small sword or dagger, and are obviously about as dangerous as any wounds can be. If the heart be punctured, then the blood may escape into the cavity of the pericardium, and so put a stop to the action of the heart; but any of the great vessels within the chest may be opened into, and death may result from that just as speedily. If the pleura costalis be perforated, then collapse of the lung from entrance of air will ensue; and the danger from pneumo-thorax is not confined merely to the inflammation and empyema which are almost certain to result, but may also depend upon the consequent overworking of the sound lung by the large amount of blood which is suddenly thrown upon it: and this is one of the very few cases in which it is necessary to withdraw a considerable amount of blood from the system, in order to avert a threatened danger.

Perhaps an intercostal artery may be injured, although that is unlikely; or the lung itself may be pierced, and blood may be poured from its vessels into the pleural cavity; from both of these accidents hæmato-thorax may result.

Hæmorrhage from the lung of course cannot be stopped by any direct means; but the intercostal artery may be included in a ligature passed round the rib near which it lies. The other methods of stopping this kind of hæmorrhage consist essentially of a plug placed upon the inner surface of the rib, so as to compress the wounded artery. This may be managed by applying a broad bandage round the chest, and pressing upon that part of it lying opposite the wound so as to force it in, and form a little sac within the chest; then plugging this sac with lint, and finally tightening the bandage. The same may be done by inserting a little bladder of water, and pulling it outwards.

But in all punctured wounds of the chest, it is proper to lay the patient on the wounded side, as by that means the products of inflammation are allowed to escape, and the entrance of air is prevented. But should the wound be closed? That is a question which does not admit of an unconditional answer. The primary dangers, without doubt, are sinking and hæmorrhage; but after these, pneumo-thorax, hæmato-thorax, and suppurative pleurisy, may affect the punctured side, while pneumonia may seize the opposite lung; and the line of practice to be pursued in every case must be judged of from the peculiar circumstances under which the patient is placed. Gunshot wounds are very bad, and are seldom recovered from.

THE ABDOMEN.—Of the four great cavities, the abdomen is the only one that appears suitable for undergoing great alterations in capacity. As already stated, the cranial contents do not vary in amount; but as the lungs are continually changing their volume, and as the pelvic contents, especially in the female, are also liable to change, the abdominal cavity, by its capability of altering its capacity, besides being admirably adapted for its own functions, is also made to act as a cavity of reserve.

The Abdominal Regions, as they are called, result from the artificial subdivision of its surface by imaginary lines, which are drawn from the cartilages of the eighth ribs to the centre of Poupart's ligament, and intersected by two horizontal ones, the upper of which encircles the body opposite the cartilage of the ninth rib, the lower encircling it on a level with the upper border of the crest of the ilium. In this way the surface is divided into nine regions, of which the hypogastric, umbilical, and epigastric, lie in the mesial line from below upwards, having respectively the iliac, the lumbar, and the hypochondriac regions on each side of them. But the upper boundary of the epigastric and two hypochondriac regions is the diaphragm; and as this septum is continually altering its position in the movements of respiration, so the contents of these regions also vary in amount. The lower boundary of the hypogastric and two iliac regions is the margin of the true pelvis, formed by the promontory of the sacrum and the ilio-pectineal line.

Now the abdominal viscera are most naturally arranged into those lying above and those below the level of the transverse colon and its meso-colon. The transverse colon lies immediately behind the abdominal wall, extending from right to left, a little above the level of the umbilicus. Above it lie the liver, the gall-bladder, the pancreas, stomach, duodenum, and spleen. Below it lie the convolutions of the small intestine, attached by the mesentery, and covered by a fold of peritonœum called the omentum ; also the ascending and descending colon.

Within the right hypochondriac region are found the right lobe of the liver, the gall-bladder, ascending portion of the duodenum, the hepatic duct, and vessels entering the liver. The left hypochondriac region contains, besides the fundus of the stomach, the transverse colon, the smaller end of the pancreas, the splenic omentum, spleen, and vessels.

The epigastric region contains the pyloric-half of the stomach, the left lobe of the liver, and lobulus Spigelii ; the aorta, ascending vena cava, thoracic duct, upper border of the pancreas, the cœliac axis, and semilunar ganglia; the vena azygos, vena porta, hepatic artery, crura of the diaphragm, and splenic vessels.

The parts within the umbilical region are the transverse portion of the duodenum, the jejunum, the pancreas, aorta, vena cava, receptaculum chyli, and vena azygos, besides the omentum, mesentery, lacteals, and glands.

Within the right lumbar space lie the ascending colon, kidney, and renal capsule, descending portion of the duodenum and part of the jejunum.

The descending colon, a kidney, and some convolutions of the small intestine, occupy the left lumbar region.

In the hypogastric are found part of the jejunum and ileum; the sigmoid flexure of the colon, and the commencement of the rectum; the bladder, when quite full, the uterus during pregnancy and some vessels.

The right iliac space contains the termination of the ileum, ureter, vas deferens, with the spermatic vessels, the cœcum, and appendix vermiformis.

Spermatic vessels, with the vas deferens, the sigmoid flexure of the colon and ureter, occupy the left iliac region.

The parts that have now been described as lying *in* the spaces, properly speaking, lie opposite to them, and occupy positions more or less deep, some being even on the vertebral column. Indeed, when the abdomen is opened, it is only the liver, with its gall-bladder, the stomach, part of the intestines and great omentum, that are exposed to view, although the extent of the omentum will greatly modify the amount of intestinal tube seen. The abdominal wall is constituted posteriorly by the quadratus lumborum and psoas magnus, three layers of abdominal muscles surrounding and confining the rectus, and sometimes also the pyramidalis in front.

The external oblique muscle of the abdomen arises from the eight inferior ribs, midway between the spines of the vertebræ and the mesial line in front. Its fibres extend obliquely inwards, and are inserted into the anterior half of the outer lip of the crest of the ilium ; into the spine of the pubis forming Poupart's ligament ; and from this by a horizontal membranous expansion into the pectineal line of the pubis ; lastly, into the front of the pubis and linea alba. There are two points about this muscle that require remark; first, that its muscular fibres terminate in the aponeurosis, in such a manner as to form a curved border, with its convexity turned inwards, and extending from the anterior superior spine of the ilium upwards and inwards; and, second, that none of the fibres are inserted into the crest of the pubis, for above this lies the external abdominal ring. Poupart's ligament has been called the lower pillar, and the lower border of the aponeurosis itself has been called the inner pillar of the ring. Strong aponeurotic fibres connect Poupart's ligament to the aponeurosis, and so fill up the triangular fissure between these, except for a little space just above the crest. This little space is occupied by a delicate fascia called inter-columnar, and is the external abdominal ring. The internal oblique arises from the outer half of Poupart's ligament, and from the anterior two-thirds of the middle lip of the crest of the ilium: its fibres radiate both upwards and downwards, and it is inserted into the borders of the six lower ribs, into the linea alba, and with the transversalis abdominis into the crest and pectineal line of the pubis. This last insertion is called the conjoined tendon.

The transversalis abdominis arises from the outer third of Poupart's ligament; from the anterior three-fourths of the inner lip of the crest of the ilium; by the lumbar fascia, from the tips of the spinous processes, as well as the tips and roots of the transverse processes of the lumbar vertebræ: And lastly from the inner surfaces of the six lower ribs, where it indigitates with the diaphragm. It is inserted into the linea alba, and with the internal oblique into the pectineal line of the pubis.

The rectus abdominis arises from the crest of the pubis behind the conjoined tendon, is intersected in its upward course by three tendinous bands that cross it transversely, and is inserted into the cartilages of the fifth, sixth, and seventh ribs. For the upper three-fourths of this muscle, the aponeurosis of the internal oblique splits into two laminæ, one of which lies with the tendon of the transversalis behind, the other with the tendon of the external oblique in front of the rectus. For the lower fourth of the rectus, the aponeuroses of all three muscles pass entirely in front, and so strengthen the abdominal wall.

The mode in which the rectus, quadratus, and psoas, are enclosed by the abdominal muscles, is very striking.

The arteries to the abdominal walls are the lumbar passing outwards behind the psoas and quadratus; the ilio-lumbar partly ascending between these muscles, partly supplying the iliacus internus and ilium, and partly curving round the crest of the ilium to communicate with the circumflex ilii artery; the deep epigastric in front, ascending first between the transversalis fascia and peritonœum, secondly, between the rectus and its sheath, and thirdly, within the substance of that muscle, anastomosing with the superior epigastric derived from the internal mammary.

The nerves to the abdominal wall are, besides the six lower dorsal, two musculo-cutaneous branches that emerge from the outerborder of the psoas-magnus. These are the ilio-hypogastric, supplying the integument on the hypogastric region, and the ilio-scrotal, supplying the scrotum.

The anterior and lower part of the abdominal wall is strengthened by transversalis fascia, which, under the name of iliac, invests the iliacus internus, and changing its name to pelvic, descends below the brim of the pelvis. It is thin above and behind, where there is sufficient strength without it.

The peritonœum is the most extensive serous sac in the body, and, like all similar membranes, consists of a parietal layer to line the cavity, and of a visceral layer to form partial investments for the various organs. Indeed, it must be remembered that, as a serous membrane is a *shut* sac, it cannot possibly form anything more than a partial covering to an organ, otherwise the nutrient vessels could not enter. Without attempting to describe the various folds of peritonœum, and without tracing it to prove that it must be what every one knows it is, namely, a shut sac, it will be sufficient to remark, that if the relative position of the abdominal viscera be clearly understood, then by considering how a shut sac could be made to cover them in the best manner possible, the course it actually takes will be more clearly understood than by the most lengthy description.

The liver, stomach, ascending duodenum, spleen, transverse colon, and small intestine, are well covered by peritonœum. The remaining viscera receive very imperfect investments. The mesentery extends from the left side of the second lumbar vertebra to the right sacro-iliac synchondrosis, and consequently the superior mesenteric artery, as it lies in the attachment of that fold, has its concavity turned to the right. Recollecting how the posterior wall of the abdomen is formed, and that it is only the space of the vertebræ between the psoas muscles that is uncovered, the disposition of the great vessels within the abdomen will be easily remembered. The abdominal aorta emerges through the diaphragm opposite the last dorsal vertebra, and inclining rather to the left side of the body of the fourth lumbar vertebra, it divides into the two common iliac arteries, which are about three inches long, and divide opposite the sacro-iliac synchondrosis into external and internal iliac. The external rests on the inner border of the psoas, the internal descending into the pelvis.

The outer border of the aorta is in contact with the left psoas muscle; its right border with the thoracic duct, which commences in the dilated receptaculum chyli upon the second and third lumbar vertebræ; and just to the outer side of this lies the vena cava, which is formed upon the intervertebral substance between the fourth and fifth lumbar vertebræ by the junction of the two common iliac veins, which at this point are crossed by the right common iliac artery. The cava ascends along the right crus of the diaphragm, and is then imbedded in the posterior part of the liver before it passes through the opening for it in the cordiform tendon.

The parts that rest upon the abdominal aorta from above downwards, are the liver, the splenic vein, the pancreas, transverse duodenum, left renal vein, and the mesentery. The branches given off by the aorta are the phrenic, the cœliac axis, dividing into the gastric, hepatic, and splenic, the superior mesenteric supplying the small intestine with the ascending and transverse colon ; the supra renal to the capsules, the renal, the spermatic, inferior mesenteric, and middle sacral. The four lumbar arteries arise from the aorta along its extent. With the exception of the phrenic, which ascend upon the under surface of the diaphragm, the lumbar, which pass outwards behind the psoas and quadratus lumborum to supply the muscles, and the middle sacral, which runs down the centre of the sacrum, the branches of the abdominal aorta are distributed to viscera only.

The inferior cava, in its upward course, receives the lumbar veins, the right spermatic, the right and left renal (the latter being the longest, and receiving the left spermatic vein), the supra-renal and phrenic veins, and lastly, the hepatic veins.

Around the psoas magnus are clustered the branches of the lumbar plexus. The two musculo-cutaneous nerves emerge from its outer border above the crest of the ilium; the external cutaneous emerges just below the crest, and runs over the iliacus internus muscle; the great anterior crural is seen deeply embedded between the psoas and iliacus a little above Poupart's ligament. The genito-crural comes forward from the anterior surface of the psoas: and the obturator emerging from the inner border of the same muscle and extending downwards above the level of the obturator artery, passes out at the foramen in the same relative position.

The right common iliac artery crosses not only the two common iliac veins, but also the vena cava. It is sometimes crossed by the ureter, but a plexus of the sympathetic and peritonœum always rest upon it.

The left common iliac rests on the fifth lumbar vertebra, and, like the other, may sometimes be crossed by a ureter. The inferior mesenteric artery, and the sigmoid flexure of the colon, with the peritonœum, rest upon it.

As the external iliac artery descends from the division of the common iliac to the lower border of Poupart's ligament, where it becomes femoral. it is above the level of the brim of the pelvis and lies first to the inner border of the psoas, and then just upon it. The peritonœum, with the spermatic vessels firmly attached to its under surface, rests upon the artery; and when in operating upon the iliac, the peritonœum is lifted up, of course the spermatic vessels are removed with it. The vas deferens crosses over the external iliac close to Poupart's ligament, and the ureter generally crosses it close to its origin above. A quantity of subserous cellular and adipose tissue rests on the artery near the ligament; a couple of circumflex ilii veins lie across it; a chain of lymphatic glands rest upon it; and, lastly, the genital branch of the genito-crural passes downwards on it and supplies it. The external iliac vein lies first to the inner side, and then gets beneath the accompanying artery, being held with it to the inner part of the psoas by a thin lamina of iliac fascia. On the left side the vein lies along the inner border of the artery for its whole extent, as it has to join with the internal vein to form the left common iliac, which crosses over to join the right one.

The Liver has a brown colour, measures ten to twelve inches from right to left, six to seven from before backwards, and is about three inches in depth at its thickest part. It weighs forty-eight to fifty-eight ounces in the male; forty to fifty in the female: it therefore slightly exceeds the brain in average weight.

In the erect posture of the body, the thin anterior border of the liver and part of the gall-bladder project beyond the margin of the ribs, and lie in contact with the abdominal wall, so that they may be distinctly felt. The posterior border of the liver, which rests upon the aorta and vena cava, is thick and rounded, and the folded edge of the peritonœum that surrounds the uncovered space on this border is called the Coronary Ligament.

The folds of peritonœum that hold the liver to the abdominal wall are the lateral ligaments; that which holds it to the under surface of the diaphragm is the suspensory ligament. The obliterated umbilical vein is the only ligament of the liver that is not formed by peritonœum.

As the upper surface of the liver is convex, its under surface is concave, and the fissure for the umbilical vein, together with that for the ductus venosus, constitutes the separation between the right and left lobes. The fissure for the gall-bladder, and behind this the fissure for the cava, constitute the right boundaries of the lobulus quadratus at the anterior, and of the lobulus Spigelii at the posterior part. The transverse fissure separates the two last-mentioned lobules from one another, and gives entrance to the portal vein and hepatic artery, and exit to the hepatic duct and lymphatics.

The liver consists of an enormous number of small bodies about the size of a millet seed. These are the acini of Malpighi. They have a lobulated or polygonal shape, and indeed suit themselves to the peculiarity of their position. One side, which is called the base of every lobule, invariably lies in contact with the lining membrane of a hepatic vein, and therefore constitutes a portion of its wall. All the rest of its surface is in contact with a plexus of the portal vein, and a plexus of the hepatic duct: the branches of the former entering, those of the latter emerging from the surface of the acinus.

An acinus is composed of a mass of secreting cells, 1·800th to 1·1000th of an inch in diameter, giving origin to a plexus of biliary ducts, the exact commencement of which has never been seen. Through the cellular mass the minute capillaries of the portal vein converge in a plexiform manner, and are collected at its centre into an intralobular vein, which opens in the centre of the base of the lobule, and therefore pours its blood at once into a hepatic vein, which, from it position, as might be imagined, is called sub-lobular.

The hepatic veins are often called hepatic canals, and on the surface of a transverse section of the liver they appear open and empty. But other channels are also observed, and these are called portal canals: they always contain cellular tissue and absorbents, which surround a collapsed branch of the portal vein, and a contracted hepatic artery and hepatic duet. These portal canals may be justly considered as mere inversions of the general surface of the liver ; and at the transverse fissure, which is their commencement, the general investing membrane, called *Capsule of Glisson*, is inverted, and lines them as they radiate from the fissure towards every peripheral part of the liver. The hepatic artery appears to serve for the nourishment of the cellular tissue; and its terminal branches open into those of the portal vein previously to the entrance of the latter into the proper substance of the acinus. The hepatic canals in many places cross, and in some parts lie parallel, to the portal canals, and they converge from all the periphery of the organ towards its posterior border, where, in two or more trunks, it pours the blood into the ascending cava, which in this part of its course lies deeply imbedded in the posterior border of the organ.

When not required in the duodenum, the bile regurgitates along the cystic duct into the gall-bladder, the inner surface of which is honeycombed, and the mucous membrane of the cystic duct forms a spiral fold which greatly facilitates the exit of the inspissated bile when required for chylification.

The Kidney is about four inches long, two in width, and one in thickness, and weighs rather more than four ounces. It is embedded in fat, rests upon the lower part of the diaphragm, and upon the quadratus lumborum and psoas magnus muscles. It lies opposite the last dorsal, and three upper lumbar vertebræ. Its convex border is turned outwards, and the ureter emerges from the border that lies next the vertebræ. The ureter is eighteen inches in length, has the width of a goose quill, and extends downwards to the fundus of the bladder, and in that course crosses the commencement of the external iliac artery, and is crossed by the spermatic artery above, and by the vas deferens, close to the bladder. The renal artery enters the kidney just in front of the ureter, and the renal vein emerges from it just in front of the artery.

The kidney is kidney-shaped, for nothing else so well defines its appearance; and the supra-renal capsule which surmounts each is really very like a cocked hat. The colour of the kidney is a purplish brown, and it has a firm capsule beneath which the veins form a plexus on the surface of the organ, and lie in contact with its cortical part. The cortical portion occupies about three times the space taken up by the medullary, and is very much more vascular. Each uriniferous tubule constitutes an independent element of the renal mass. It commences in the cortical part by a dilated pouch, and after various convolutions in the same section of the organ it becomes straight, and passes through the medullary portion, uniting with another tube, and finally terminating on the nipple-like apex of a cone. It is on account of the arrangement of its vessels that the kidney is so remarkable. The branches of the renal artery are either distributed at once upon the convoluted part of the uriniferous tubule, or, in the first place, pushing the basement membrane before them into the sacculated commencement of the tubes, they subdivide, become very tortuous, and form the superficial part of a glomerulus, of which the centre is entirely composed of further subdivisions and convolutions of the same vessel. These last are accumulated into an emergent vessel, which is distributed to the convoluted portion of the tubule, as an auxiliary to the branch of the renal artery that passes directly to the tubule. The blood is returned from the surface of the tubule by a branch of the renal vein.

The urinary secretion is supposed to be produced in a very peculiar manner. The epithelium lining the tubule separates from the blood the highly nitrogenized principles, as well as the alkaline and earthy salts of the urine; but the vessels of the glomerulus are understood to act as a highly complex and beautiful filter by which the water, most likely in a pure state, is separated from the blood in such quantity as the animal economy may require; and being poured out at the very end of the tubule, serves the purpose of continually washing down the more consistent elements of the secretion.

Very little if any areolar tissue exists in the minute structure of the kidney. A granular or cellular matrix is described as surrounding the tubes. The cones, which are formed by the straight part of the tubuli uriniferi, are usually fifteen in number, their rounded extremities that project towards the pelvis of the kidney, present the apertures of the tubules, which are not more than 1·200th of an inch in diameter. As, of course, the mucous lining of the ureter is continuous with the minute structure of the kidney, the calyces, as they are called, are mere pouches of the membrane that surround one or more of the papillæ, and conduct the urine more directly into one of the two or three dilatations of the pelvis of the kidney.

Composition of the Urine.—The urine is an acid secretion of sp. gr. 1020. It contains 67 grains of solid matter in 1000. About 40 ounces of urine are voided in twenty-four hours, and of this quantity nearly two ounces are solid matter. Nearly an ounce of this solid matter is Urea, which is the cyanate of ammonia ($Cy\ O,\ NH^4O$), and is remarkable for having the composition of a salt, but the behaviour of a base ($C^2\ H^4\ N^2\ O^2$); that is to say, it will form salts by uniting with mineral or other acids. It contains 47 per cent. of nitrogen, and by it is removed about 9-10ths of all the nitrogen taken in by the food. Eight grains of uric acid, in the form of urate of ammonia; six grains of phosphoric acid, as phosphates of soda and ammonia, of lime and magnesia; chlorides of sodium and potassium; sulphates of soda and potash; colouring matters (red and yellow), with mucus, epithelium, and traces of other matters, make up the remaining part of the solids. In peculiar states of the system, other ingredients are found in the urine. For example, hippuric acid may be increased by the administration of benzoic acid; uric acid and urea are both increased during the action of colchicum; urate of soda almost constantly exists during the desquamative stage of scarlatina, whether the patients have or have not been treated with soda salts; phosphates are increased in all diseases of debility; cystine is a peculiar secretion; bile may be present in jaundice; sugar in diabetes.

•The urine passed soon after drinking watery fluids (urina potus) has a low sp. gr. even 1008; that passed soon after a full meal (urina chyli) is alkaline and heavy, often 1030 or more; the urina sanguinis has the standard sp. gr. 1020.

The quantity of urine in health will vary with the state of the skin and the amount of liquids taken, and its qualities will alter according to the kind of food. In diabetes, in which the sugar existing in the blood acts as a powerful diuretic on the kidneys, the quantity of urine may be greatly increased, often to ten pints, sometimes even to twenty, thirty or more pints in twenty-four hours. The sp. gr. of such urine may be from 1030 to 1055, and the quantity of solid matter thrown off is very large.

Diăbetic Urine.—The sugar may be detected either by adding a drop or two of solution of sulphate of copper to a little of the urine contained in a test-tube, then adding liquor potassæ equal to half the amount of urine, then heating the urine, which will deposit brown oxide of copper; or by adding a little yeast, and keeping the urine at a temperature below 80° F. when the sugar becomes changed into alcohol and carbonic acid. This last is a very delicate test.

Bile in the Urine is detected by first of all separating any albumen that may be present by heat and filtration, concentrating by evaporation, then mixing a little of the urine with two-thirds its bulk of pure sulphuric acid, added drop by drop; next adding a grain or two of sugar or a little syrup, agitating the mixture and allowing it to stand a few minutes; the urine will assume a more or less intensely red colour, with a tinge of violet. A drop or two of nitric acid let fall into the midst of a little of the urine on a clean white plate causes a play of colours producing green, pink, and yellow.

Kiestein is a spermaceti-looking pellicle, that forms on the surface of the urine of pregnant women, after it has been allowed to stand for several days. It consists principally of crystals of triple phosphate, to which it owes its brilliancy, with a few oil granules. The appearance of this pellicle is considered by some as a good diagnostic of pregnancy.

In *acute dropsy*, after scarlatina, the urine is dense (beyond 1030), and often highly albuminous. The albumen may of course be detected by heat and nitric acid. Casts of the uriniferous tubes, composed of epithelium, generally with oil granules, or of urate of ammonia, may also be observed.

In fatty degeneration of the kidney, also, the urine is albuminous, but sometimes the albumen disappears for a time. Fatty casts of the tubules are always present. The urine in this case is of low sp. gr. (1015 to 1005.)

Spermatozoa are present in the urine of those who are affected with spermatorrhœa.

Iodide of potassium may exist in the urine of patients under treatment by that salt; and either a drop or two of nitric acid, or a little free chlorine, will cause the purple vapour of iodine to be evolved, which may then be tested by starch solution.

In *Diabetes Insipidus*, the ordinary amount of solid matter is thrown off, but the amount of water is so greatly increased, that the sp. gr. is very low, even 1001

The Spleen is of a purplish grey colour, about five inches long from above downwards, about three from before backwards, and from within outwards about one and a half. Its convex surface corresponds with the diaphragm opposite the ninth, tenth, and eleventh ribs; its concave surface lies against the great end of the stomach when that organ is nearly empty, but upon its back part when distended. The tail of the pancreas touches its lower and inner part: it lies in front of and above the left kidney. The spleen consists of a peritoneal covering, a fibrous capsule, and a brown pulp, besides vessels and peculiar whitish bodies.

The capsule, which contains a considerable amount of yellow elastic tissue, folds inwards at the hilus, and then passes towards the surface. As it enters the hilus it forms sheaths for the large branches of the splenic artery and vein, and fibrous bands pass outwards from these sheaths to the capsule, and also intersect the organ in every direction. The spaces between these bands are filled by the following structures:—first, a brown granular pulp, consisting of bodies about the size of yellow blood-cells; second, white corpuscles about 1·60th of an inch in diameter; third, the branche of the splenic artery, which terminate either in a minute plexus amongst the pulp, or in small branching vessels upon which the white (or Malpighian) corpuscles are attached; fourth, of a venous plexus, the exact arrangement of which, and indeed of all parts of the spleen except the large vessels, has not been determined.

The supra-renal capsules are placed on the anterior and inner part of the upper extremit of the kidney. They are about an inch an a-half long, just about the same width, and quarter of an inch thick. They consist of a c tical portion composed of perfectly straight divided tubes, set side by side perpendicul to the surface, and of a central pulpy part that is soft and brown, and appears to be composed of a venous plexus. The tubes are 1.700th of an inch in diameter, have a bright yellow colour, and contain, besides granules of various sizes, corpuscles like the colourless blood-cells. Numerous blood-vessels enter the substance of the capsules by a great many fissures on their surfaces, and ramify copiously around the tubes. The functions of these bodies are quite unknown.

Here, in connection with the spleen and supra-renal capsules, the thymus and thyroid glands may be noticed.

The Thymus Gland lies in the anterior mediastinum, has a greyish-pink colour, and extends upwards on the front of the trachea. It is composed of two elongated lateral lobes best developed about the second year, and each lobe consists essentially of an elongated central cavity, communicating by lateral dilatations with very minute saccules; the entire cavity, with all its sacculations, being filled with a whitish fluid. This fluid owes its colour not to granules like those of chyle, but to cells very much resembling the colourless corpuscles of blood.

The gland gradually becomes atrophied, and about adult age has almost disappeared.

The Thyroid Gland is situated on the front of the trachea and along the sides of the larynx. It consists of two lateral lobes, connected below by an isthmus. This organ is soft, reddish, and highly vascular; and when cut into, a thin glairy fluid exudes from the cut surface, and then its structure is seen to be vesicular, in the same way as the ultimate structure of the thymus. There is, however, no central cavity. Cell nuclei and nucleated cells float in the glairy fluid.

The Stomach is shaped like an irregular cone, is ten or twelve inches long, and about four in width at its widest part. It weighs a trifle more than four ounces. The small curvature is concave upwards, about three inches long, and is connected to the under surface of the liver by a fold of peritonœum, called gastro-hepatic omentum, in the right border of which are contained the portal vein with the hepatic artery and duct. To the left extremity, which forms part of the great curvature, is attached the gastro-splenic, and to the remainder of the great curvature the gastro-colic omentum.

When empty, the stomach is rather flattened from before backwards, and its muscular fibres are uniformly contracted throughout, the mucous membrane being of course thrown into rugæ.

The arteries of the stomach are, first, the coronary of the gastric, which runs along its small curvature and anastomoses with the superior pyloric of the hepatic. Along the great curvature the gastro-epiploica dextra from the gastro-duodenalis joins with the gastro-epiploica sinistra from the splenic. Small branches extend over the great curvature from the gastric to join the vasa brevia of the splenic; and from the arteries that run along the curvatures numerous branches extend in every direction, first between the peritonœal and muscular coat, then between the layers of muscular fibres, to terminate finally by supplying the mucous membrane. As the liver occupies the right hypochondriac, the epigastric, and part of the left hypochondriac region; so the stomach, which chiefly occupies the left hypochondriac, extends across the epigastric into the right.

The Duodenum first ascends to the under surface of the liver, then descends perpendicularly in front of the right kidney, and lastly, passes upwards to the left, behind the pancreas, to the left side of the second lumbar vertebra : in this course it turns round the head of the pancreas.

The Pancreas is shaped like a dog's tongue, has a reddish cream colour, is about seven inches long, and extends across the first lumbar vertebra, lying just behind the stomach. Behind its upper border lie the splenic artery and vein : the artery is above the vein, and is very tortuous : the vein is straight, and by its junction with the superior mesenteric, behind the head of the pancreas, forms the portal vein. The superior mesenteric artery and vein pass through the substance of the lower part of the pancreas. The duct of this gland runs through its substance from left to right, and opens with the ductus communis choledochus into the duodenum at the lower part of its descending portion, having previously channelled the coats of this intestine for half an inch.

The Jejunum is about ten feet long, is more vascular, and less convoluted than the ileum ; it varies from an inch and a-half to one inch in diameter ; but the ileum is not more than an inch and a quarter, and sometimes even less than an inch. Part of the umbilical and the left iliac regions are occupied by this intestine.

The Ileum is about fifteen feet long, and very convoluted. It occupies part of the umbilical, the right iliac, and the hypogastric regions, and before it terminates in the cœcum it descends even into the pelvis.

The duodenum gets a branch from the gastro-duodenalis of the hepatic. The superior mesenteric artery gives off twelve or more branches from its convexity, which subdivide and unite with one another to form four or five sets of arches, from which the vessels finally ramify on the jejunum and ileum : the cœcum, the ascending and transverse colon, each receive a branch, and it is the branch to the last named intestine that, by anastomosing with a branch from the left colic, forms the longest anastomosis in the body.

The inferior mesenteric artery lies behind the peritonœum, and extends to the left iliac fossa : it supplies the descending colon, the sigmoid flexure, and the upper part of the rectum.

The Great Intestine consists of cœcum, colon, and rectum.

The cœcum is shut off from the small intestine in such a manner by a valve, that no matter can regurgitate from the large intestine except under very extraordinary circumstances—such, for example, as the vomiting that sometimes occurs in intus-susceptio, or in strangulated hernia. It is very remarkable indeed, that powerful action of the ordinary muscular fibres surrounding the intestinal canal, is always attended by relaxation of those circular fibres called sphincters: what strengthens the one set, appears to paralyse the other. The cœcum is firmly bound down to the right iliac fossa by the periſonœum.

The ascending colon reaches the under surface of the liver, and like the descending one, is firmly bound to the abdominal wall by peritonœum; it lies in front of the right kidney, and making a sudden bend, terminates in the transverse colon. This curves to the left side between the layers of the meso-colon, and then bends downwards to become continuous with the sigmoid flexure, so forming the descending colon which lies on the left kidney and the left crus of the diaphragm. The sigmoid flexure is the narrowest part of the great intestine, forms a curve like the letter S, and lies in the left iliac fossa, surrounded by peritonœum, which forms a meso-colon around it. The widest part of the great intestine is the cœcum, which is about two and a half inches in diameter; *and from* this the diameter of the intestine gradually diminishes to the sigmoid flexure, which is not more than an inch and a half wide. The sacculations of the great intestine are both transverse and longitudinal; its whole length, including the rectum, is from five to seven feet.

The rectum is about eight inches long, and is not sacculated. It first curves backwards and downwards into the hollow of the sacrum, extending from the left sacro-iliac synchondrosis to the mesial line in front of the third piece of the sacrum; it then curves forward to the tip of the coccyx, in contact with the vesiculæ seminales and prostate gland, and in the female with the cervix uteri, and back of the vagina; lastly, it curves downwards and backwards, and terminates at the anus. The rectum has the same diameter as the sigmoid flexure, except at its lower part, just within the internal sphincter ani. As already stated, the longitudinal fibres, which are chiefly collected into three bands along the colon, are spread equally over the rectum; and an inch above the anal aperture, the circular fibres form a thick band about half an inch long, called the internal sphincter ani.

Punctured wounds of the Abdomen, like those of the thorax, may cause almost immediate death;

for if a knife be driven deep into the abdomen, the aorta, the vena cava, or the heart itself, may be pierced. Indeed the amount of injury that may result will depend not only on the depth to to which the puncturing instrument is driven, but also upon the direction that it may happen to take. In general, however, punctured wound of the intestine is almost the only injury that comes under treatment. Vomiting of blood, or passage of blood by stool, may arouse suspicion that the intestine has been injured; but if the injured part do not protrude at the wound in the abdominal parietes, or at least be apparent through it, then it is well to know that it must not be sought for by a probe, or by any other means: probing can only do mischief; and whatever information might be derived from its use could be of no avail. If the intestine be nearly divided across, then the only safety for the patient will be to attach the cut extremity of the intestine to the wound in the abdominal parietes, and in this way produce an artificial anus. The surgeon must use his own judgment in regard to the amount of injury with which it would be proper to return a punctured intestine. The most favourable cases for stitching together the lips of a wound in the bowel, are those in which the incision is oblique, and in such cases the margins of the peritonœum are to be turned inwards, stitched together, and the intestine replaced. If the puncture be very slight, then the mucous membrane will protrude and fill up the aperture; and this protruded part of the membrane, as well as the stitches that are introduced when the wound is more extensive, becomes absorbed into the cavity of the intestine.

Where the kidney, gall-bladder, stomach, or great intestine have been injured, then the escape of acrid matter will cause a peritonitis of the most fatal description, while puncture of the liver or spleen are more likely to destroy life by hœmorrhage.

Cases that are remediable, are the more likely to recover the less that they are interfered with.

The Pelvis.—When all the soft parts except the ligaments are removed from the pelvis, it consists of a cavity having a brim, an oval outlet and three apertures in its walls, namely, the obturator, the great and small sciatic foramina. To understand the structure of the pelvis, it is necessary to know how the outlet and the apertures in the pelvic wall are filled up.

The great sacro-sciatic foramen is occupied by the pyriformis, almost all the sacral plexus, and three out of the four branches of the internal iliac that emerge from the pelvis. The superior gluteal nerve, artery, and vein lie above the muscle, the great and small sciatic nerve, the pudic nerve, the ischiatic and pudic artery pass out below the muscle.

The small sacro-sciatic foramen is occupied by the obturator internus as it is emerging from the pelvic cavity, and by the pudic artery, vein, and nerve, which, as soon as they have emerged from the greater foramen, cross the spine of the ischium, and enter the small one.

The obturator foramen is almost entirely occupied by membrane, but the obturator artery, vein, and nerve emerge at its upper part, the nerve being nearest the bone, and of course above the others.

The pyriformis arises from the front of the sacrum, between the anterior sacral foramina by three or four slips, and the sacral plexus rests on the muscle, and is held to it by the pelvic fascia. The internal obturator muscle arises around the obturator foramen, and is held in its position by the obturator layer of the pelvic fascia, which, close to the tuberosity of the ischium, joins with the upper edge of the great sciatic ligament, which of itself forms a groove for the artery and nerve, and so these important parts are retained in their places: it must be remembered, that it is only on the inner side of the tuberosity and along the ascending ramus of the ischium, that any important artery lies along the pelvic wall in any thing like an exposed position.

From the lower and back part of the pubis close to the symphysis, from the inner surface of the spine of the ischium and between these two parts, from the angle of division (marked by a white line) of the pelvic fascia into vesical and obturator, arises the levator ani, and its fibres extend almost vertically downwards, to be inserted into the lower end of the rectum and into the middle line of the perineum in front and behind that intestine, as far back as the coccyx, and as far forward as the central tendinous point of the perineum. From this statement, it is obvious that the most anterior fibres of the two levator ani muscles lie parallel to one another, as they run downwards to be inserted into the central tendinous point; and in the slit-like space between them, lies the membranous part of the urethra, which they surround and support like a sling; and it is just as obvious that the posterior surface of the muscle lies in contact with the prostate, or rather with its capsule. And as for the central tendinous point, it is merely the thickened centre of the posterior border of the triangular ligament. It is unnecessary to remark, that the levator ani is the only true opponent to the diaphragm; for by the contraction of either the one or the other, the abdominal cavity is lessened, and the levator, assisted by the coccygeus, closes the outlet as correctly as the diaphragm separates the abdominal from the thoracic cavity. Of course the anus is the only aperture in the levator ani of the male; but in addition to this, there is the vaginal aperture in the female, the fourchette separating the one from the other. The posterior border of the levator ani is in contact with the lower border of the coccygeus muscle which arises from the border of the sacrum and coccyx, and is inserted into the spine of the ischium.

The Ischio Rectal Fossa is the deep space that lies between the outer surface of the levator ani and the inner surface of the obturator fascia. It is occupied by a quantity of fat.

The triangular ligament is a strong, but thin and transparent membrane, stretching from the *rami of* the ischium and pubis on one side, to the same parts on the opposite side, and becoming continuous with the periosteum in front of the symphysis pubis. It is not triangular, for its lower border is concave, and it measures an inch and a half in depth in the mesial line. All the parts in front of this ligament are external to the pelvic cavity; and the parts that lie behind it may be considered as within the cavity, although, properly speaking, the levator ani is the proper boundary.

Although the ligament now described as the triangular ligament, or ligament of the urethra, obviously has for its purpose to retain and protect the urethra, and several other parts in their relative positions; and although it is the only membrane that stretches continuously from side to side, yet, as the fascia that invests the anterior surface of the levator ani is often called the posterior layer of the triangular ligament, the following parts may be stated as being contained between the two layers of that structure, namely, the membranous part of the urethra which passes through it one inch below the symphysis pubis; Guthrie's muscles spreading out on its upper and under surfaces; Cowper's glands situated, one on each side, just below it; the internal pudic vessels and nerve on each side, close to the ramus, and of course the dorsal arteries and vein perforate the anterior layer as they pass forward, and recede from the penis.

The two transversi perinæi muscles arise from the lower part of the ramus of the ischium, close to the tuberosity, but on the pelvic side of the attachment of the erector penis, and run upwards and inwards to be inserted into the central tendinous point of the perinæum, blending at their insertion with the origins of the accelerator urinæ, and of the sphincter ani. Their posterior borders constitute the proper lower boundary of the triangular ligament; for in this situation it is that the deep layer of the superficial perinæal fascia that invests the erector penis, accelerator urinæ, and transversi perinæi, becomes amalgamated with the triangular ligament, and with the fascia that invests the under surface of the levator ani.

Of the male organs of generation, the testicles and penis lie in front of the triangular ligament, —the vesiculæ seminales, the prostate and Cowper's glands behind it.

The Penis consists of two corpora cavernosa, which give firmness to the organ in its erected state, and of the corpus spongiosum, which is firmly attached to the under surface of the former, and channelled by the urethra.

The corpora cavernosa, under the name of crura penis, are firmly attached to the grooves on the inner side of the rami of the ischium and pubis; but are blended together in front of the symphysis pubis, to which they are attached by the dense fascia that surrounds them, and which is called the fascia penis.

Each crus consists of erectile tissue intersected in every direction by fibrous plates, and surrounded by a dense fibrous sheath half a line to a line in thickness, and sending inwards the fibrous plates before mentioned, which are a great deal thicker than those intersecting the erectile tissue of the corpus spongiosum. Where the crura join together, their fibrous investments, considerably diminished in thickness, constitute a perpendicular septum, which as it extends forward towards the rounded termination of the corpus cavernosum, becomes much thinner; and as there are elongated spaces in it, that give it a comb-like appearance, and allow the erectile tissue of the two sides to communicate, it is called septum pectiniforme.

The erectile tissue itself is composed of three structures; *first*, a dilated venous plexus, that when cut into, looks like a number of communicating saccules; *second*, a capillary net-work that terminates abruptly in these; *third*, small arteries that terminate suddenly in several spirally twisted sacculated extremities: these last are called *helicine arteries*, and are lodged in the sacculations of the venous plexus, formed by the venous membrane being reflected around them. They are limited to the pelvic part of the organ.

The structure of the corpus spongiosum is quite identical with that of the cavernosum, only there are very few helicine arteries, and its fibrous sheath and septa are very much thinner than those of the cavernosum. The corpus spongiosum is divided into the bulb, the body, and the globus. The bulb lies against the under surface of the triangular ligament, and gives the expanded form to the accelerator urinæ, which arises from the central tendinous point of the perinæum, embraces the bulb, and is inserted into the upper part of the ramus of the pubis, as also into the dense fascia on the dorsum of the penis. On each side of the bulb lie the two crura, which are closely invested by the erector penis, arising as it does from the ramus and tuberosity just behind them, and expanding over them to be inserted with the fibres of the accelerator into the fascia penis. The anterior rounded extremity of the corpus cavernosum is received into a little pit at the upper and back of the glans penis, which is about an inch in length.

Branches of the pudic nerve supply the corpora cavernosa and corpus spongiosum. The dorsal arteries of the penis lie one on each side of the dorsal vein, which receives nearly all the blood from the penis, and, perforating the triangular ligament between the apertures for the dorsal arteries, forms the prostatic plexus. The remainder of the blood from the penis, along with that derived from the superficial structures, of the perinæum, and from the hœmorrhoidal plexus of veins surrounding the lower extremity of the rectum, is returned by the internal pudic vein.

As formerly mentioned, the integument of the penis is thin and loosely attached to the organ by cellular tissue devoid of fat; and this, together with the two layers of superficial fascia, and some non-voluntary muscular fibres, constitutes the bag which contains the testicles, and is called the scrotum.

Operation for Phymosis.—It must be observed, that the great contraction of the prepuce, which sometimes occurs during inflammation affecting it, is due almost entirely to inflammatory thickening and contraction of its mucous layer only. Instead, therefore, of slitting up the prepuce entirely, it is only necessary to push it back as far as possible, and then clip through its mucous membrane. The skin will retract freely, and then another bit of the mucous membrane is to be divided. In this way, without entirely cutting through the prepuce, the phymosis may be removed.

The Urethra varies in length from seven and a half to nine and a half inches, but the average length is about eight. It consists of the prostatic, membranous, and spongy portions.

Immediately in front of the prostatic portion lies the membranous, which is rather less than an inch in length, and is surrounded by circular fibres, called the deep fibres of Santorinus, and held between the two layers of Guthrie's muscles, which arise by a narrow tendon from the ramus of the pubis, and extending horizontally inwards, spread out like a fan upon the upper and under surface of the membranous part.

The spongy part is named according to the portion of the corpus spongiosum through which it passes.

Stricture of the Urethra is either inflammatory, spasmodic, or permanent.

Inflammatory stricture is the result of acute inflammation, extending along the urethra, and accompanied by spasmodic contraction of Guthrie's muscle. Spasmodic stricture, as it is called, is a turgid state of the mucous membrane, with a half-erected state of the corpus spongiosum, which gives passage to the urethra. Permanent stricture is caused by the exudation and organization of lymph in the submucous cellular tissue surrounding the urethra.

Inflammatory Stricture takes place most frequently in young persons, and is very often the result of exposure to cold and moisture during the presence of gonorrhœa, and under the additional excitement produced by over-indulgence in spirituous liquors.

Now, it is particularly worthy of notice, that in cases either of inflammatory or of spasmodic stricture, the first thing that the patient complains of is a great desire to pass water, but an entire inability to do so; and this indicates that not only the urethra itself is affected, but the bladder also.

As the parts are highly irritable, it comes to be a question whether any attempt should be made to pass a catheter, without in the first place endeavouring to lessen the amount of inflammation. The way is tolerably clear: If we get the patient as soon as he is attacked, then the warm-bath, opiate enemata, and, if the patient be feverish, bloodletting also should be employed. This indeed is a case of inflammation requiring the remedies proper for inflammation. If within twelve hours the treatment be not successful in relieving the stricture, then the catheter must be tried. But if a patient has been already suffering for many hours, introduction of the catheter must be attempted at once. No doubt there is risk of exciting a higher inflammatory action, but no other risk can compare with that of extravasation of urine. Of course, if the catheter cannot be passed, the bladder must be punctured.

Spasmodic Stricture is more troublesome than dangerous, and perhaps rarely occurs except in those who are already affected with permanent stricture. Cases that are unattended by permanent stricture, may very likely be improved by the occasional introduction of a catheter; by this means the irritability of the membrane appears to be diminished.

Permanent Stricture is most frequent at the bulb ; next, at about four and a half inches from the orifice ; next, at the corona glandis, about an inch from the orifice ; and least frequent at the orifice itself. Stricture does not occur in the prostatic portion, and scarcely at all in the membranous division of the urethra.

A stricture may be so narrow that it may feel almost like a wire constricting the tube, or it may extend for the distance of an inch or more along the tube. The narrow strictures are generally the most troublesome.

The introduction of silver bougies or catheters, twice a-week, will, in the majority of cases, produce sufficient irritation to cause the removal of the lymph; but the longer the lymph remains, the more difficult will be the cure. The urethra may be dilated to something greater than the normal width. But there are some cases which, either from original maltreatment or from some individual peculiarity, will not yield to treatment by bougies: they yield indeed, but immediately afterwards they may contract to a very small calibre, and become just as bad as ever. In these cases the lymph appears to have become developed into a true contractile structure, and if "Perinæal section" will not benefit them, at all events, it has been sufficiently proved by the fruitless attempts of the first surgeons in Europe that nothing else will. Although perinæal section may not succeed in every case, yet complete success could not be expected, and never has been obtained, from any operation whatever.

There is no doubt that with proper care, division of the stricture upon a grooved bougie will, in a majority of cases, be productive of excellent results, and may save the patient from years of misery. Although the stricture may be felt quite distinctly under the finger just like a wire, yet mere puncture can never be trusted to, and in every case the incision should be about an inch in length.

In regard to the mode of introducing the catheter, it is only necessary to remark, that force should never be used in passing a stricture. If the point of the instrument be obstructed in its progress, then it is merely to be held against, not pushed against the contracted part: in a little time the contraction will yield sufficiently to allow the instrument to pass. It does not appear that allowing the catheter to remain in the urethra for any length of time has any superiority over its immediate removal.

Bridle Stricture, as it is called, arises from the exudation of lymph on the surface of the mucous membrane, and as the result of this, formation of a string of lymph across the cavity of the tube; but as this cannot be diagnosed during life, no treatment can be applied to it.

Fistula in Perinæo is a direct communication between the urethra and perinæum, constituting a false passage for the urine. It is formed as the result of ulceration following after abscess just external to the urethra. The abscess may be caused by a blow on the perinæum, but in the great majority of cases stricture of the urethra is the cause. By the often repeated attempts to pass urine in a full stream, the urethra becomes dilated just behind the stricture, and either from mere irritation or from actual escape of a drop or two of urine through the ulcerated mucous membrane into the cellular tissue, inflammation is excited, and an abscess formed. Whether this abscess be opened externally or not, the urethra is almost certain to be opened into, and then of course a fistula in perinæo is established. The stricture must be cured before anything can be done for the fistula. When the stricture has been cured either by bougies or by perinæal section, then if the fistulous opening still remain pervious, the touch of a hot wire may perhaps close it.

Operation for Stone—Lithotomy.—Before beginning the operation, a sound should be passed, and the stone distinctly felt. After the patient has been tied up in the usual way, a director passed, and, if necessary, the perinæum shaved, the knife is to be entered either in the mesial line, or a trifle to the left side of it, about an inch in front of the anus, and the incision carried downwards and outwards to the right (the operator's right) to mid-way between the tuberosity of the ischium and the anus; this incision is about three inches long, and enters the fatty tissue of the ischio-rectal fossa. The finger is then pushed into the anterior part of the incision, and the knife lying on the outer edge of the finger, makes way for it by cutting across the transversus perinæi muscle, vessels and nerve, notching the triangular ligament, and dividing a few fibres of the levator ani. The finger nail is then lodged in the groove on the outer and back part of the staff. The point of the knife is inserted into the same groove, and with its edge looking downwards and outwards, it is then run backwards into the bladder; in this way deeply cutting into but not cutting through the left lobe of the prostate.

Unless the internal pudic artery happens to take a very unusual position, it cannot be cut. If the incision be made no further forward than has been mentioned, and if the knife be kept well behind the bulb, there will be but little chance of interfering with the artery to the bulb, unless it should happen to run very obliquely upwards and inwards.

It is to be remarked, with reference to the length of incision which may be safe in individual cases, that persons having long faces have usually also great length of pèrinæum.

The primary dangers of the operation for stone used always to be hœmorrhage and sinking; but now under the use of chloroform there will be very little fear of sinking, although of course the danger from hœmorrhage is as great as ever.

The after dangers from stone are infiltration of urine, peritonitis, inflammation of the parts about the neck of the bladder: all these are likely to be fatal: And lastly, recto-vesical fistula, as the result of injury to the rectum during the operation from not keeping that intestine sufficiently out of the way by pressing it downwards.

The rectum is much more frequently cut than any surgeon allows that it is; and indeed in many cases it is scarcely to be avoided.

The peculiar pinched appearance of countenance, rapid small pulse, brown and dry tongue, and perhaps low delirium, all indicate infiltration of urine. Symptoms very similar in kind indicate inflammation around the neck of the bladder, which is perhaps the most deadly of all.

The Testicle is an oval body, flattened from side to side, consisting of yellow glandular structure, embedded in a matrix of white fibrous tissue called the Tunica albuginea. This fibrous mass gives form to the organ, and protection to the secreting structure. Its posterior fourth is solid, and traversed only by bloodvessels and seminal ducts; but the anterior three-fourths of its substance is excavated into long triangular spaces, the bases of which look to the surface, the apices towards the thick posterior part. In the excavations are placed conical masses of convoluted tubes, that secrete the semen; and each convoluted mass terminates in one straight duct, which passes back through the apex of the space, and enters the thick part of the tunica albuginea, which is called the Mediastinum testis: then bending at right angles, it runs upwards, forming a plexus with the vessels from other cones, and emerges from the upper part as one of the twenty efferent ducts. The bloodvessels form a plexus in and upon each cone, and this plexus has received the name of Tunica vasculosa. The plexus of ducts within the mediastinum is called the *rete testis*. After the efferent ducts emerge, they become convoluted in a remarkable degree, and constitute the *globus major* of the *epididymis;* and then, one after another, they open into the principal duct, which is itself very much convoluted along the outer and back part of the testicle, to form the body of the epididymis, and becoming enlarged at its lower part into a small mass of convolutions called *Globus minor*, finally terminates in the *vas deferens.* This duct has a very small cavity in proportion to the thickness of its wall, and feels like whip-cord. Passing upwards through the external abdominal ring, and outwards along the inguinal canal, it leaves the other elements of the spermatic cord at the internal abdominal ring. It rests upon the external iliac artery, close to the origin of the deep epigastric, crosses over the hypogastric artery, and, lying to the inner side of this, to the inner side of the ureter, and along the inner border of the vesicula seminalis, it sends back a branch, which, by its convolution and sacculation, forms this body; and finally, under the new name of *common ejaculatory duct*, it passes obliquely forwards and upwards through a channel in the prostate gland, and opens into the little recess at the anterior extremity of the longitudinal fold of mucous membrane that lies in the lower angle of the prostatic portion of the urethra. This little sac is called the *Sinus pocularis*, and by transcendental anatomists is considered to be the analogue of the uterus.

The Semen is a thick whitish fluid, and consists of a clear albuminous part, in which float the spermatic filaments, and seminal granules. The former consist of an oval head and filamentous tail, and are 1-500th of an inch in length, but only a twelfth of that in breadth at their broadest part: the latter are globular, and 1-4000th of an inch in diameter. Besides these there are also mucus, epithelium cells, &c. which form a part of the secretion.

Semen cannot be obtained unmixed with the fluids of the vesiculæ seminales, the prostate and Cowper's glands.

The spermatic artery enters the back part of the mediastinum testis, and the branches of the veins emerge from the same part. These last intertwine round the artery in the spermatic cord; and when dilated by varix, they feel like a bag of worms—and this feeling is characteristic of Varicocele.

As the testicle, previously to the seventh month of utero-gestation, lay on the psoas, just under the kidney, and then descended into the scrotum, so, as it lies in that bag, the testicle must have coverings formed of thin laminæ of all parts that lie in its way downwards. In its descent it first carried forwards the layer of peritonœum lining the posterior abdominal wall,—this is the *tunica vaginalis vera:* then the peritonœum lining the anterior wall,—this is the *tunica vaginalis reflexa.* Then pushing before it first the subserous cellular tissue, then the thin part of the transversalis fascia lying just to the inner side of the origin, and immediately under the curved lower border of the transversalis abdominis muscle, and finding the origin of the internal oblique lying in its way, it carried down the obstructing fibres in loops around it under the name of cremaster muscle. Lastly, finding the external abdominal ring to be obstructed by the thin inter-columnar fascia, it carried this before it and entered the scrotum, in which it is found lying, surrounded by a considerable quantity of loose cellular tissue, called from its position *subdartoid.*

As the two layers of peritonœum passed downwards, their edges became amalgamated, and therefore shut off from the general cavity of the peritonœum, forming the sac of the tunica vaginalis. The peritonœum is in fact lost upon the cord, except in rare cases in which the sac of the tunica vaginalis still communicates with it; and in these cases, there is constant liability to the descent of the intestines into the tunica vaginalis.

Inguinal Hernia.—In connection with the descent of the testicle, the anatomy of hernia is very interesting. First, it must be remembered that when the abdominal muscles are entirely removed, with the exception of Poupart's ligament, the transversalis fascia is the only proper boundary of the abdominal wall. It is firmly attached to the ligament below, and then enters the pelvis. Now, the entire surface of the transversalis fascia is concealed from view by the transversalis muscle, except the small part of it that lies between the lower border of the transversalis and Poupart's ligament. And it is in this small space that both varieties of inguinal hernia take place. Perpendicularly behind the centre of this space the deep epigastric artery ascends. To the outer side of it the fascia is thin, to the inner side also it is thin, and through one or other of these thin parts it is that oblique and direct inguinal hernia protrude. As for the oblique hernia, it passes through the thin part to the outer side of the epigastric artery, namely, through the same aperture as the testicle passed at first, and of course it must just have the same coverings, although, in general, after carrying before it the intercolumnar fascia, it does not enter the scrotum, but merely protrudes under the skin and superficial fascia in the inguinal region.

As the internal oblique and transversalis muscles have the same width of insertion (conjoined tendon) although a different extent of origin, direct inguinal hernia will obviously have only the peritonœum, transversalis and intercolumnar fasciæ, with the superficial fascia and skin, but no cremaster muscle, since there is no internal oblique to obstruct its passage. Where the weak part of the transversalis fascia lies behind the conjoined tendon, the hernial protrusion may either split that tendon, or carry it forward as a covering: this, however, is rare. Both herniæ in reality are oblique, but the direct is less oblique than the other. The intercolumnar fibres being too strong to permit the insinuation of a hernia between Poupart's ligament and the lower border of the aponeurosis of the external oblique, all protrusions through the uncovered space of transversalis fascia must find their way through the intercolumnar fascia, and over the crest of the pubis.

The inguinal canal, which is the channel extending from the external to the internal abdominal ring, is about an inch and a half long, bounded in front by the intercolumnar fibres, and that part of the internal oblique muscle arising from Poupart's ligament in front of the outer weak point in the transversalis fascia, and behind by the transversalis fascia and the conjoined tendon. Poupart's ligament may be considered as the floor, the inferior arched borders of the internal oblique and transversalis as the roof of this canal.

This canal lodges the spermatic cord in the male, the round ligament of the uterus in the female. The cord passes downwards and inwards, resting on Poupart's ligament, and consists of the vessels, nerves, duct, and lymphatics of the testicle, bound together by sub-peritonœal areolar tissue and fat, and by a tube of the transversalis fascia. A cremasteric branch comes from the epigastric artery, a deferent branch from the superior vesical, the former going to the cremaster muscle, the latter to the vas deferens. The genital branch of the genito-crural nerve supplies the cremaster, and the scrotal branch of the ilio-scrotal passes down the cord, and makes its exit at the external abdominal ring.

In reducing inguinal hernia, it is necessary to push the protruding part first backwards, then upwards and outwards, trusting that it will then find its way into the abdominal cavity. But if it be strangulated, then it is necessary to divide the strangulating part whatever it is. A strangulation may occur either at the external or at the internal abdominal ring, perhaps even in the peritonœum. An incision must be made along the line of Poupart's ligament, beginning opposite the internal ring, and extending to the fundus of the sac. Layer after layer is to be divided by pinching up each layer with the forceps, opening into it, passing a director under it, and slitting it up. More layers than have been enumerated will be found to exist; but this arises from the cellular tissue increasing in amount and becoming laminated. The peritonœal covering of the intestine or the omentum, if that part be protruded, will be known by its glistening appearance, and probably also by the presence of fluid between it and the bowel. If the stricture be not at the external ring, then the peritonœum must be opened into, the director passed through the internal abdominal ring, and a hernia knife run on after it, so as to cut through both the peritonœum and the transversalis fascia at the internal abdominal ring. The stricture generally is in the transversalis fascia, so that division of that structure might appear to be sufficient. But as there is no certainty that the strangulation is not the result of exudation of lymph into the subserous cellular tissue, it is better to run the risk of cutting the peritonœum than to permit the chance of the bowel being returned in a strangulated state.

Diseases of the Testicle.—The glandular substance of the testicle is subject to fatty degeneration, and in old men it may become so disintegrated as to leave cysts in place of the proper tubular substance.

This, however, is just what might be expected from fatty degeneration and suspended function.

Chronic enlargement is very apt to occur after hernia humoralis, and consists chiefly in thickening of the tunica albuginea.

The testicle may also be affected with simple vascular sarcoma or fibrous tumours, with or without cysts.

Then there may be medullary sarcoma, which may very likely become a fungus hæmatodes. Of course there may also be melanotic matter as a constituent of the cancerous disease.

Hard cancer in the testicle is very rare, but may extend to it from the scrotum, in which it is not uncommon under the name of chimney-sweeper's cancer.

Excision had better be performed in all tumours except chronic enlargement, as it is impossible to predict what may happen to any tumour, however simple it may appear.

The scrotum may become greatly thickened (Elephantiasis scroti): blood may also be effused into the sub-dartoid cellular tissue, constituting something like an hœmatocele. Serum may collect in the cavity of the tunica vaginalis between the visceral and reflected layers of this membrane, constituting hydrocele. In this case it is only necessary to puncture with a trochar, so as neither to wound the testicle nor the veins of the scrotum. As soon as the fluid begins to escape, withdraw the trochar, and push on the canula. When the sac is empty, inject a drachm of tincture of iodine, shake it about, withdraw the canula, and send the patient to bed. The swelling which prevails for a day or two after this is of no consequence.

Hœmatocele is an accumulation of altered blood, or of something very like it, in the cavity of the tunica vaginalis. Try the same treatment as if it were a hydrocele, but, if that fail, then dissect away a portion of the tunica vaginalis which is usually thickened, so that adhesive inflammation may be set up. Hœmatocele, or at least an accumulation just like it, has been met with in the neck, over the shoulder, and in other situations. Perhaps injection with iodine might do if the mere opening of the sac were not sufficient.

The pelvic viscera in the male are the rectum, the bladder, the vesiculæ seminales, and prostate gland.

The bladder, when empty, lies entirely within the pelvic cavity, and is triangular and flattened *from* before backwards. When distended, it occupies part of the abdominal cavity, and may be felt in the hypogastric region above the level of the pubis. Keeping in mind that the bladder, like other pelvic organs, must accommodate itself to the curve of the pelvic cavity, however distended it may be, it will always be curved to a certain degree from above downwards, and rather flattened from before backwards. Although the mucous membrane, with the exception of that space called the Trigone, is wrinkled when the bladder is empty, it becomes quite smooth whenever the organ is filled with urine.

After the ureters have made a channel obliquely through the coats of the bladder for the extent of an inch, they open on its inner surface under little valvular folds of the mucous membrane, about an inch and a-half from the inner orifice of the urethra, over which also there is a little fold called the Uvula.

The triangular space of mucous membrane included between these three apertures, is the Trigone vesicale, and belongs to that part of the bladder called the Inferior Fundus. It is paler in colour than the rest of the membrane, but much more sensitive; and it exactly corresponds with the space on the under surface of the bladder, where it is uncovered by peritonœum, and rests on the upper surface of the rectum. This space is bounded by the recto-vesical fold of peritonœum behind, by the prostate gland in front, and by the vesiculæ seminales, with the vasa deferentia lying to their inner borders on each side.

The peritonœum does not cover the bladder either below or in front, and the pouches of this membrane, that lie on each side and behind the bladder, are called the posterior and lateral false ligaments. They disappear when the organ becomes distended.

The true ligaments of the bladder are formed partly by pelvic, and partly by vesical fascia. The pelvic fascia folds backwards from each side of the posterior surface of the symphysis pubis, and is attached to the anterior surface of the bladder. With these are amalgamated the tendons of the bladder, from which the muscular fibres arise that encircle the organ, and become inserted into the lower part of the sphincter; these fibres, therefore, not only compress the fluid that is contained in the bladder, but also pull open its internal aperture. The lateral ligaments of the bladder are formed by the vesical layer of the pelvic fascia; and between them and the sides of the bladder are enclosed a plexus of veins which is continuous with the plexus lying between the layers of the capsule of the prostate. The Urachus or suspensory ligament is a relict of fœtal structure, and contains between its layers the obliterated hypogastric arteries which, as they ascend along the upper surface of the bladder, are sometimes considered as two additional ligaments.

The muscular coat is composed of three layers, of which the fibres continued from the ureters constitute the internal one.

The expulsion of urine is a semi-voluntary act under ordinary circumstances. The presence of urine distending the bladder gives rise to a feeling of desire to expel it, and by the voluntary contraction of the abdominal muscles, the abdominal, and consequently the pelvic cavity, is so far diminished, that the bladder must evacuate its contents. But the question arises, why does the sphincter at the neck of the bladder in particular yield, when those of the stomach, if that organ be full, do not? It is no doubt through the influence of the will to a certain extent. It is very remarkable, however, that all voluntary efforts at expulsion of urine are quite useless, if from delicacy or any other cause, the muscular fibres of the bladder do not respond to the mandate of the will; and the reverse of this is quite as obvious in cases where the urine cannot be retained, even by the most powerful effort of the will.

The proper performance of micturition, and of defœcation also, depends on the healthy condition of the spinal cord at its lower part, and it is worthy of remark, that the pelvic viscera over which we have control are copiously supplied with spinal nerves.

The *Prostate Gland* is shaped like a chesnut, surrounds the neck of the bladder, and contains the prostatic portion of the urethra. It measures from side to side an inch and a-half; from before backwards rather more than an inch; and three quarters of an inch from above downwards.

The urethra forms a triangular channel through its substance nearer to its upper than to its under surface. It is rather more than an inch in length, and presents along its lower angle an elevated fold of mucous membrane called *Veru montanum*, at the anterior extremity of which is the little pouch called *Sinus pocularis*, into which the two common ejaculatory ducts open. On each side of this fold are the numerous openings of the prostatic ducts. The middle part of the prostatic division of the urethra is wider than any other part of the tube.

The substance of the prostate gland is easily torn to pieces, but when invested in its capsule, it is very firm. Its minute structure has been already stated to consist of branched ducts terminating in vesicular pouches ; but, instead of its lobules being loosely held together by cellular tissue like those of the salivary glands or pancreas, they are supported by thin septa sent inwards from the inner layer of the capsule of the gland.

The capsule of the prostate consists of two layers, which are separated from one another by the prostatic plexus of veins and lymphatics. The inner layer invests the gland very closely, and sends in processes to support its submucous tissue. The outer layer is thick, and formed by the pelvic fascia.

The *Vesiculæ Seminales* are elongated bodies situated on the under surface of the bladder, converging in front, where close to the base of the prostate their ducts join with the vasa deferentia, to form the common ejaculatory duct. Each one consists of a tube six or eight inches long, as wide as a goose quill, and bent in a zig-zag manner just like the tubes of the epididymis. It is sacculated at intervals, and terminates behind near the junction of the ureter in a cœcal extremity.

Fistula in Ano.—It is a remarkable fact, that whenever an abscess forms in the cellular tissue of the perineum, close to the rectum, there is almost no possibility of hindering the coats of the rectum from being perforated, and a preternatural passage for the fœces being established between that part of the intestine and the surface of the perineum near the anus. When it is borne in mind that the rectum is sacculated just above the internal sphincter, and especially that it is just upon this part of the intestine that the greatest degree of pressure is exerted during defœcation, then it will not appear wonderful that the internal aperture of a fistula is always about an inch and a quarter above the anus.

Some surgeons ascribe the formation of abscesses that produce fistula to irritation or perforation of the mucous membrane by acrid intestinal matter, or by a fish-bone, &c.; but certainly most of the cases are found to have arisen from the application of the ordinary causes of inflammation to the perineum itself: as for example, by persons thinly clad sitting down upon a cold stone. The coats of the rectum may be perforated either previous or subsequent to the perforation of the integuments of the perineum. But however far the abscess may extend upwards along the side of the rectum, and however numerous the external openings may be, there is never more than one internal opening in any case of fistula.

Even in an ordinary case of sinus it is sometimes impossible to cause contraction and closure of the sac, without laying it open; it is not to be wondered at therefore that the fistula through which irritant matter is constantly passing, will not close. The only plan to cure it is to lay it open in its whole extent: in fact, to make the cavity of the rectum and that of the fistula into one. But it is never necessary to cut through the coats of the rectum higher up than the internal aperture of the fistula: the division of the two sphincters, indeed, appears to be all that is really required. Perfect cleanliness and rest will generally complete the cure. The sphincters reunite, but not before the cavity of the fistula has been filled up by granulation.

The pelvic viscera in the female are the Uterus, the Ovaries, the Vagina, the Rectum, and Bladder.

The Uterus is pear-shaped, and flattened from before backwards. It is inclined forward, and curved, to suit the axis of the pelvic cavity; and it lies enveloped in the peritoneum, between the rectum behind and the bladder in front. The peritoneal fold that contains the uterus is called the Broad Ligament, and is reflected upon the adjacent surfaces of the rectum and bladder.

In its unimpregnated state, the uterus is three inches long from above downwards, two and a quarter broad at its upper part, and about an inch from before backwards. After the uterus has once been impregnated, it generally measures about five inches in length. The part of it that lies above the level of the fallopian tube is called its fundus. The cervix, which projects into the vagina, and is invested by its lining membrane, is about an inch long; and that part of the organ between the tubes and the cervix is called the body of the uterus.

Although the uterine cavity is described as being triangular, yet as the walls of the uterus are thicker at the middle part of the fundus and at the lower part of the body than they are at the entrance to the fallopian tubes, the cavity is bounded by surfaces that are convex inwards. The canal of the cervix is spindle-shaped; but, like the uterine cavity, it is a mere fissure between the anterior and posterior walls of the uterus, which lie very nearly in contact, and have the mucous membrane thrown into a double row of transverse folds, called the uterine arbor vitæ.

The internal os uteri, by which the uterine and cervical cavities communicate, is perfectly circular, but the external os uteri (like the mouth of a tench), is rather transverse, and of course at right angles to the vaginal orifice. Like the other viscera of the pelvis, the uterus is slightly curved, to suit itself to the axis of the cavity, and consequently lies at an angle to the vaginal cavity, the wall of which is attached around it and ascends higher up upon it posteriorly than anteriorly. The uterine arteries have a remarkably zig-zag arrangement on the outer surface of the uterus; and then, as usual, they enter and supply the organ.

The ligaments of the uterus are the broad ligaments already mentioned, and the two round ligaments, one of which is attached to each angle of the uterus just where it becomes continuous with the fallopian tube. It then passes upwards and outwards to reach the internal abdominal ring, and then extending downwards in the inguinal canal, finally terminates in the cellular tissue of the labium. It is of some consequence to remember that a tube of peritonœum surrounds the round ligament and forms a pouch in the labium, for sometimes an accumulation of serous fluid takes place in this pouch and constitutes a hydrocele, which may perhaps require the same treatment as it would in the male. As the uterus is by no means firmly held in its place by its ligaments, it is very liable to displacements of various kinds, some of which occur from causes that are not at all easy to explain. Anteversion, where the fundus is thrown forward behind the pubis, retroversion where the fundus is thrown back into the hollow of the sacrum, and prolapsus where it may descend into the vagnia, all require the utmost skill in diagnosis, and the most carefully applied mechanical aid.

As the posterior lip of the uterus hangs lowest in the vagina, and is therefore most exposed to injury, it is also most liable to disease; and, consequently, it is in this situation that ulceration most frequently occurs. Indeed, the cervix uteri, the greater part of which lies in the vagina, is from *its exposed* position affected with all the diseases that attack the uterus except fibrous tumour, which appears to be limited to the body and fundus of the organ. Besides its liability to be affected by prurigo, impetigo, and scabies, the cervix uteri may be attacked by the croupy or diphtheritic inflammation, which may terminate in ulceration. Generally, however, ulceration commences just within the margin of the os uteri upon its posterior lip, and from that it may spread over all the vaginal surface of the cervix. The appearance of the ulcer will vary of course according to its depth; and it is very necessary to be aware that an unusual enlargement of the follicles of the mucous membrane (follicular inflammation) may produce a granular appearance of the cervix bearing so strong a resemblance to the surface of a granulating sore as not readily to be distinguishable from it. Very often the lips of the uterus become hypertrophied and elongated by the exudation of plastic lymph into its substance, although sometimes small abscesses even may form in this situation. Syphilitic ulcer may affect the cervix in the same manner as it may any other mucous surface; but its characters may not always be so obvious in this as in other situations.

Cauliflower excrescence, which may either be attached to the posterior lip, or may surround the os uteri, has a bright red colour, and from its tuberculated appearance, has been thought to resemble the white part of a cauliflower. It consists chiefly of bloodvessels; its surface is smooth and shining, and a thin discharge is continually trickling from it. Excision of the cervix is perhaps the most efficient treatment.

Corroding ulcer is characterized partly by the rapidity of its progress, partly by the absence of any deposit in the uterine substance in advance of it.

Cancer of the uterus is distinguished from all other diseased conditions of that organ by the immobility of the cervix, in which, almost without exception, the cancerous deposit at first begins. The cervix appears to be firmly agglutinated to the parts that surround it, no doubt by the deposition of cancerous matter in the cellular tissue that unites the uterus and vagina to the bladder in front, and to the rectum behind; and consequently the cervix cannot be moved without dragging with it the parts that surround it. Besides this indication of cancer, there will also be the almost stony hardness and purplish colour of the part: and perhaps a discharge of blood may be the first symptom to arouse suspicion of the nature of the case.

When ulceration is fairly established, then the cervix may be found to be excavated like the interior of a dice-box.

There is great doubt that cancer is remediable at any stage of its progress, but it is certainly irremediable when advanced to the ulcerative stage. Still something may be done to relieve pain by giving opiates, &c.

Chronic inflammation, enlargement and induration of the cervix, often will not yield to any ordinary treatment, and as in the case of other parts that have become remarkably indolent from the persistence of chronic inflammatory action, very strong measures may be required to excite the absorbents of the part to increased activity. It is not surprising, therefore, that the application of solid caustic potash to the indurated cervix by destroying a considerable portion of the diseased structure, is often followed by the best effects: of course, it will be necessary to introduce a speculum, and to protect the vagina by the introduction of vinegar previous to and during the operation. It is upon the same principle that blisters are applied, not only to very callous indolent ulcers, but also to the indurations that surround old sinuses, &c.

The circumstances of the uterus are altogether very peculiar, for congestion must take place at every menstrual period, and so, of course, the progress of the case towards cure is continually retarded. This fact must always be kept in mind, and every means must be adopted to obviate, as far as possible, the evil effects of the periodical excitement.

The syphilitic, corroding, and other ulcers must be treated according to the ordinary principles of surgery, always recollecting, however, that the cervix uteri is, for some unknown reason, more disposed to ulceration, and perhaps more difficult to rouse to healthy activity, than any other part of the body.

Chronic inflammation of the mucous membrane lining the uterus may result in the discharge of purulent matter, and is then called Uterine Leucorrhœa. This variety may be distinguished from the Vaginal by inserting a sponge tent into the os uteri at night, and observing whether or not the patient has been free from discharge during the night. If the removal of the tent be followed by discharge of matter, there can be no doubt that the discharge comes from the uterine cavity. But leucorrhœa is almost always accompanied by an ulcerated state of the cervix. According to its consistence and its source, the leucorrhœal discharge may have almost any appearance; it is sometimes clear and thin, at other times glairy, opalescent, greenish, tinged with blood, &c.

In some cases a membranous cast of the uterine cavity is thrown off, either entire or in shreds, and this discharge, which may occur once in three months or oftener, is attended with great pain. It is not decided that this membrane is formed by the inflammatory process, and its resemblance to the decidua which is formed after impregnation, cannot escape notice. Perhaps the use of Ergot of Rye might be beneficial in aiding the expulsion of the false membrane.

Amenorrhœa may occur in two very different states of system, namely, in Plethora and in Anœmia. It is unnecessary to remark, that the treatment required in these two cases is very different. In plethora, general depletion and local stimulation are the remedies. Among the most powerful of the local remedies may be mentioned the application of leeches to the vulva, and the application of nitrate of silver to the os uteri, or what is still better to the lining membrane of the uterus. Sometimes even the caustic fails, and then it will be as well to try the introduction and retention of a uterine bougie for a day or two. Such remedies as the wine of aloes and the tincture of aloes and myrrh, administered either with or without a small quantity of cantharides, may perhaps assist the local means. For the anœmic variety, constitutional stimulation by means of tonics, especially chalybeate tonics, constitutes the most important part of the treatment: and to this should be added the use of the hip-bath, &c. at the menstrual period.

Profuse flow of the menstrual discharge requires careful management. Gallic acid is an excellent astringent in the more severe cases: perhaps 5 or 6 grains may be given several times a day.

The Fallopian Tubes are three or four inches long, and derive their peritonœal covering from the upper border of the broad ligament in which they are partly enclosed. They are widest near the fimbriated extremity, which is, as its name implies, divided up into flattened fringes, on which, as before-mentioned, the remarkable continuity of serous with mucous membrane is established: this is the only example of it in the human body. The uterine orifice of the tube is very minute, and will scarce admit a bristle.

The Ovary is almond-shaped, and is about an inch and a-half long, three-quarters of an inch across at its widest part, and about half an inch thick. It is almost entirely enveloped in the posterior layer of the broad ligament, and it lies horizontally with its small end attached to one angle of the uterus just behind the fallopian tube, the rounded end being turned outwards. It is largest in the virgin state, and gradually diminishes in size. At each menstrual period the fimbriated extremity of the fallopian tube, which is attached to a portion of the peritonœal covering of the ovary, grasps the surface of that organ around the situation of a large graafian vesicle, which bursts, and throws an ovum into the tube by which it is conveyed to the uterus. The cicatrices of the ruptured graafian vesicles are called corpora lutea, and it has been imagined that those associated with pregnancy are distinguishable from the others ; but they are not.

Ovarian Dropsy is either a collection of fluid between the peritonœal surface and the proper coats of the ovary ; or consists of dilated graafian vesicles ;

or of one large sac containing numerous smaller ones associated with a gelatinous fluid ; or, lastly, of a collection of hydatids within a gigantic parent. Collection of fluid in the fallopian tube is sometimes reckoned an ovarian dropsy. It will be useful to remember in the diagnosis of ovarian disease that the ovaries may just be touched, but no more, by the finger introduced per vaginam.

The vagina is about five inches in length, and consists of a dilatable fibrous structure, lined by mucous membrane, and partially covered externally by serous membrane. A venous plexus surrounds the lower part of the vagina just outside of the sphincter vaginæ. This plexus is perfectly similar to the plexus surrounding the lower extremity of the rectum. There is something like an erectile structure situated immediately external to the mucous membrane between it and the fibrous sheath.

In the pelvic cavity in the female there is a large amount of cellular tissue lying under the peritonœum, and also between the layers of the pelvic fascia. Intense inflammation of this tissue, followed by exudation into its substance, constitutes Pelvic Cellulitis, which is so frequent in women both before and after impregnation.

About the most remarkable symptom of this affection is the intense fever that accompanies it, but it is only local examination by the vagina or rectum that will diagnose the disease. The symptoms that are present in diseases affecting the pelvic viscera will exist also in this: but except they be very severe they have no very characteristic peculiarity. The quantity of lymph that is poured out in such cases is sometimes very great. It varies in its degree of plasticity, but, independently of this, the position in which it is exuded will of course increase or diminish the tension, so that sometimes the inflammatory tumour feels as hard as a cricket-ball; and were it not for the particular history of the case it might be mistaken for cancer itself.

Keeping in view that the uterus and vagina lie between the rectum and bladder, it will be obvious that exudation may occur either between the bladder and uterus, or between the uterus and rectum, and that the lymph may form a thick layer like a roof to the vagina, and in an extreme case may project upwards and lie in one or other iliac fossa.

In such cases, although the patient may not die from the disease itself, yet she may suffer for years from pelvic abscess, and from the exhausting hectic that may attend it. Copious bloodletting, followed by calomel and opium in such doses as to affect the system with the greatest rapidity, constitute the proper treatment. When the abscess has formed, it ought to be punctured ; but in case of accident, an exploring needle may first be introduced.

Whenever the iliac fascia has descended below the brim of the pelvis, it is named the pelvic fascia. As an undivided layer it closely invests the anterior surface of the sacrum, pyriformis muscle and sacral plexus of nerves, as far forward as the spine of the ischium; but in front of this the fascia divides into two laminæ, namely, the vesical and obturator. This division takes place, as already mentioned, opposite a white line extending from the spine of the ischium to the lower part of the symphysis pubis.

The obturator layer closely invests the inner surface of the obturator internus muscle, and is attached to the ramus of the ischium and pubis, as well as to the edge of the great sacro-sciatic ligament. As it joins with that ligament, it forms investments for the pudic vessels and nerve.

The vesical layer descends to the side of the bladder, and splits up into three layers. The uppermost one constitutes the lateral ligament of the bladder, and encloses the vesical plexus of veins; the middle one extends from side to side, between the rectum and bladder forming the recto-vesical fascia; and the inferior lamina forms a sling to the rectum.

If the position of the levator ani muscle be kept clearly in view, and if the fascia be considered merely as the investment for the upper surface of that muscle, then there can be no difficulty in understanding that the fascia is quite smooth and continuous, when viewed from above, and that in the male it appears to be attached around the lower part of the rectum and bladder, whereas in the female it is also attached to the side of the vagina. It holds all these organs beautifully in their relative positions.

Lying between the fascia and the pelvic viscera are the internal iliac arteries, with their branches surrounded by sheaths of the sympathetic nerve, and accompanied by branches of the sacral plexus that supply the rectum, bladder, &c. The internal iliac artery descends to the upper margin of the great sacro-ischiatic foramen, and then divides into its branches, which are given off rather irregularly, from its two primary divisions. The umbilical, middle vesical, and middle hæmorrhoidal arteries supply the abdominal as well as the pelvic wall; but the gluteal, sciatic, pudic, and obturator, emerge from the pelvic cavity for the supply of the surrounding parts.

Of these vessels, the pudic is certainly the most important. Having emerged from the great sacro-ischiatic foramen, it immediately enters the small one by crossing the spine of the ischium, with its nerve lying to its inner side. It then ascends the rami of the ischium and pubis, along with a part of the pudic nerve, and finally emerges below the pubis, and supplies the structures of the penis. In its upward course, it is first protected by the obturator layer of the pelvic fascia, and sends branches inwards to the lower part of the rectum; it then lies along the ramus of the ischium, covered by the crus penis, and supplies a superficial branch to the perinæum; it then enters behind the triangular ligament, and sends branches through it: one that enters the crus penis, another that runs transversely inwards to the bulb of the corpus spongiosum: lastly, it perforates the triangular ligament, close under the symphysis pubis, just to one side of the dorsal vein of the penis, and attended by its nerve, becomes the dorsal artery of that organ. The pudic veins bring back but a small part of the blood supplied to the penis by the arteries; they derive their branches chiefly from the bulb, and from the crura of the corpora cavernosa.

When the artery to the bulb is given off quite near to the tuberosity, then it runs obliquely upwards and inwards towards its destination, and cannot fail to be cut in the operation for stone; but, in general, its position is so perfectly transverse, that with ordinary care there is no fear of cutting it.

The obturator artery is important, not so much from its size as from the very dangerous communication that sometimes exists between it and the deep epigastric artery. The communicating branch, when small in size, almost invariably lies along the inner border of the external iliac vein; but when large, it almost invariably lies along the outer border of Gimbernat's ligament, and therefore could not escape being cut through in the operation for strangulated femoral hernia.

Puncture or laceration of the Pelvic Viscera, although very dangerous, may sometimes be recovered from under favourable circumstances. In a case where the sharp end of a paling was dr downwards and backwards into the bladder, patient (a healthy boy) recovered in spite of i tration of urine, consequent inflammation, recoveries of this kind, however, are attribut to unusually careful management, with a g system to work upon. But in cases where per have fallen from a height upon a spike, w has thus been driven into the pelvis, the in has in nearly all of them been too desperate t recovered from.

It is necessary to bear in mind, that when blood or urine escapes into the tissues behind triangular ligament, then, on account of the tinuity of the superficial with the deep peri fascia, the extravasated fluid extends upward stead of backwards, and may be found infiltra the scrotum, or even the cellular tissue of groin.

The Crural Space. — Poupart's ligam which has received the name of the crural a serves not only as the bond of union between fascia of the abdomen and that of the thigh, also serves to retain in their relative posit the muscles, vessels, and nerves, that em from the abdominal cavity and enter the tl

The space included between Poupart's ligament in front, Gimbernat's ligament to the inner side, and the os innominatum behind, is occupied to more than the outer half of its extent by the iliacus and psoas muscles. The external cutaneous nerve lies on the outer border of the iliacus, just to the inner side of the anterior superior spine of the ilium, while the great anterior crural nerve is embedded to half its depth between the muscles. The remainder of this space, namely, that portion of it included between Gimbernat's ligament, Poupart's ligament, the psoas magnus, and the pubis, is of the highest importance in connection with femoral hernia. Through it the transversalis fascia, either undivided or nearly so, passes into the thigh, and forms a funnel-shaped sheath for the femoral vessels. But it is to be especially remarked that the femoral artery and vein occupy only the two outer thirds of this sheath, close behind Poupart's ligament; and that as the femoral sheath is closely attached to these vessels, about two inches below the ligament, there must be a conical space lying within it, just to the inner side of the femoral vein: it is to the abdominal orifice of this space, included between Gimbernat's ligament, Poupart's ligament, the femoral vein, and the pectineus muscle, that the name of *Crural Ring* has been applied. This ring is occupied by cellular tissue, a lymphatic gland, and a few lymphatic vessels.

The femoral sheath, which is derived from the transversalis fascia, or, as some say, from the iliac and pelvic fascia, becomes continuous with the ordinary investment of the femoral vessels derived from the fascia lata.

Now the fascia lata, near Poupart's ligament, splits into two layers, one of which passes behind the femoral sheath to invest the anterior surface of the pectineus muscle, and is attached to the pectineal line of the pubis; the other passes in front of the femoral sheath, and is attached to Poupart's ligament. But it is a curious fact with regard to this anterior layer of the fascia lata, namely, that it is thick from the outer border of the thigh inwards, as far as a sickle-shaped border, which lies obliquely across the femoral sheath, with its concavity turned downwards and inwards, so as to form a very firm protection for the upper and outer part of that sheath. But to the inner side of this border the fascia is thin, and becomes amalgamated with the posterior or pubic layer; and the small portion of it that covers the lower and inner part of the sheath is perforated by the saphena vein, and by numerous openings for lymphatic vessels, and is described by some as the cribriform fascia filling up the saphenic aperture ; for there is the appearance of an aperture produced by the curved border of the fascia already mentioned. It is through the apertures in the cribriform plate, as also through others, that the lymphatics pass, by which the lymphatic glands, lying under the fascia lata, are connected with those that lie superficially to it.

Femoral Hernia.—As the space under the crural arch is wider in the female than in the male, under powerful exertion the intestine sometimes protrudes at the crural ring in the former. As the fascia that lines the abdominal wall has been carried forwards around the vessels, the intestine, after its peritonæl covering, will carry before it, first, the cellular tissue that occupies the crural ring : this is called *septum crurale;* second, the sheath of the femoral vessels; third, the cribriform portion of the fascia lata; and, fourth, as the adhesion of the superficial and deep fascia is comparatively loose at the upper part of the thigh, the hernial protrusion will roll round the falciform border of the fascia lata, and ascend even above Poupart's ligament.

Femoral herniæ are often dangerous, on account of their small size, by which they may be mistaken for enlarged glands, and so escape detection, until, perhaps, strangulation has continued too long to permit of the bowel being saved from mortification.

Here it may be remarked, that the most fatal mistakes have been made by neglecting to examine the inguinal and crural regions, when the symptoms of peritonitis have suddenly made their appearance. It cannot be too carefully borne in mind, that the symptoms of strangulated hernia are in many cases quite identical with those of peritonitis; and therefore in every case where such symptoms present themselves, a most careful examination of the inguinal and femoral regions should be made. Many persons, indeed, have had hernia for a considerable time without being aware of it; and from some cause, but little suspected, such a hernia might become strangulated.

The treatment of femoral hernia is, of course, to reduce it by pressure, applied so as to push it first downwards below the level of the the falciform border, then backwards behind the anterior layer of the fascia lata, and lastly upwards into the abdominal cavity. In this, as in every other case of strangulated hernia, sudden reduction is a most suspicious sign ; and if vomiting, &c. should continue, then strangulation by the peritonœum is to be dreaded.

In operating for strangulated hernia, the incision must extend from the neck to the fundus of the tumour, and layer after layer be divided until the strangulated part be reached, when the hernia knife is to be employed, as in the case of inguinal hernia. The strangulation may be at the falciform border, but is much more likely to be at what is called the deep arch of fibres, extending from the posterior border of Poupart's ligament, and inserted immediately behind Gimbernat's ligament. The edge of the knife must be directed upwards and inwards, so that these fibres, as well as a small part of Gimbernat's ligament, may be divided. Of course if the communicating branch between the deep epigastric and obturator arteries should be large, then almost to a certainty it will lie just along the border of Gimbernat's ligament, and of course will not escape being cut.

The Femoral Artery, in its course down the thigh, is separated from the profunda by the femoral veins, and by the adductor longus muscle. As far down as the sartorius, it is covered by the fascia lata only, but below that muscle it lies in the groove formed between the adductor longus and magnus on the inner side, and the vastus internus on the outer side; tendinous fibres arch over and protect the artery, and so constitute for it a channel called Hunter's canal. At the lower border of the adductor longus the artery with its vein pass through an aperture in the adductor magnus, and so these vessels become popliteal.

The space above the sartorius is called Scarpa's; it is bounded above by Poupart's ligament, externally by the sartorius, and internally by the outer edge of the adductor longus muscle. The artery descends through the centre of that space; and it is just at the upper border of the sartorius that the operation of tying this vessel for popliteal aneurism is performed. In this operation there is no condition, perhaps, so essential to success, as that of making a very small opening in the sheath that surrounds the vessel.

The anterior crural nerve divides into its branches in the space, and the deep femoral artery which comes off from the common femoral about two inches below Poupart's ligament, passes outwards between the anterior and posterior sets of branches. The crural is more especially the nerve of extension, the obturator that for adduction; while the great sciatic, which lies on the posterior surface of the adductor magnus, supplies not only the flexors on the back of the thigh, but also part of the adductors; and in addition, it supplies all the muscles of the leg and foot without any exception.

The Popliteal Space, which is bounded externally by the biceps and outer head of the gastrocnemius, internally by the semi-membranosus, semitendinosus, and inner head of the gastrocnemius, is a space only after the removal of the strong investing fascia which holds these muscles quite close to one another. The floor of the space is formed by the triangular surface at the lower extremity of the femur, by the posterior ligament of Winslow, which is merely an expansion from the tendon of the semi-membranosus, and by the fascia investing the popliteus muscle, the tendon of which arises from a groove on the external condyle of the femur, and is held in situ by the external lateral ligament. Upon these parts, forming the floor of the space, rests the femoral artery, when it emerges from under cover of the semi-membranosus muscle: It is surrounded by cellular tissue and fat. The femoral vein ascends through the centre of the space, being formed at its lower part by the junction of the short saphena vein with the venæ comites. The popliteal nerve emerges from beneath the biceps muscle, and runs inwards to lie superficial to the vein, just as the vein lies superficial to the artery, and separated from it in the same manner by cellular tissue and fat. The peroneal nerve accompanies the inner border of the biceps and its tendon, and curves round the neck of the fibula, whereas the anterior tibial artery coming off from the popliteal artery at the lower border of the popliteus muscle, passes forward between the tibia and fibula. It may be remarked, however, that both the anterior aud posterior tibial nerves lie first to the outer side of the sheath containing the arteries which they accompany. The anterior tibial artery and nerve rest on the interosseous membrane, till close to the ankle. The posterior vessels and nerve rest on the tibialis posticus muscle, protected by a tendinous arch, then on the flexor communis digitorum, and lastly on the lower extremity of the tibia, having the flexor communis digitorum tendon to its inner side, and that of the flexor proprius pollicis just external to it.

Hip-Joint. Of the five ligaments that surround this articulation, the Cotyloid deepens the cavity of the acetabulum to such a degree that the head of the femur is held in its place even after the muscles that surround the joint have been entirely removed. The Ligamentun Teres, instead of being round as its name implies, is nearly triangular, being attached to the margins of the cotyloid notch and to the depression on the head of the femur. It does not act so much in the way of retaining that bone in its place as of *slinging* it there. The Transverse ligament extends across the notch, and retains the teres in its place. The Capsular ligament extends further down in front than behind the neck of the femur: this, of course, is owing to the position of the muscles that are inserted into the digital fossa. The Ilio-femoral ligament extends from the anterior inferior spinous process of the ilium, to the small trochanter of the femur, and greatly strengthens the front of the capsule.

When the accessory nerve of the obturator is present, it supplies the hip-joint; and under ordinary circumstances, both the obturator and the great sciatic nerve supply branches to it. Those from the latter enter the back part of the joint.

The obturator and circumflex arteries supply the joint with blood; but the free anastomosis of these, with other arteries, will always ensure a sufficient supply.

The flat head of the rectus muscle, a bursa, and the conjoined tendon of the psoas and iliacus, lie on the joint in front. The pyriformis, the two obturators, and the two gemelli, which are inserted into the digital fossa, lie in contact with the back of the joint, and the gluteus minimus covers it above.

Knee-joint.—The external lateral ligament appears to be double, because it is divided into a thick anterior, and a thin posterior part. The tendon of the biceps is split by it into two parts—one being inserted into the head of the fibula, the other running forwards and inwards to the outer tuberosity of the tibia.

The internal lateral ligament is single, and merely extends between the tibia and fibula. The posterior ligament of Winslow is perforated by the azygos articular artery from the popliteal, which supplies four other arteries around the joint, and by the azygos articular nerve from the popliteal, which along with the peroneal, supplies other nerves that correspond with the branches of the artery: the obturator nerve, which extends along the popliteal artery, also enters the joint through this ligament. The ligamentum patellæ is inserted into the anterior tuberosity of the tibia; and the ligamentum mucosum, as it is called, lies just behind it. If the ligaments which surround the knee-joint were cut through, then the two crucial ligaments would still retain the tibia, and femur in apposition. The anterior crucial ligament extends from the front of the spine on the head of the tibia to the inner side of the outer condyle. The posterior crucial, also called internal, extends from behind the spine to the outer side of the inner. The semilunar fibrous plates that lie on the articular surfaces of the tibia, are held down to it by fibres that arch over them, and constitute the coronary ligaments. The transverse ligament extends from the anterior border of the inner to the same border of the outer semilunar plate. The synovial membrane is very extensive: it is reflected around the crucial ligament, and by enclosing a quantity of fat, constitutes the mucous ligament, at the border of which it is fringed, and forms the alar ligaments.

The nerves that supply the knee-joint are in addition to the branches of the obturator, popliteal, and peroneal, already mentioned, a recurrent nerve from the anterior tibial, a branch from the long saphenus, and several branches from the muscular nerves sent to the quadriceps extensor.

The arteries of this joint are derived chiefly from the popliteal; but the anterior tibial recurrent, the anastomotica magna, and likewise the muscular arteries, assist.

The semi-membranosus, the semi-tendinosus, the gracilis, and sartorius, the biceps, the popliteus, and the quadriceps, all assist in forming along with the fascia lata, a capsule to the knee-joint.

The Ankle Joint is rather peculiar, from its having no proper posterior ligament: a ligamentous band extends from the posterior border of the inner malleolus to the same part of the outer one. The internal lateral ligament extends from the lower part of the inner malleolus like a fan, and is attached to the tuberosity of the scaphoid, to the lesser process of the os calcis, and to a little bit of the astragalus. The tendon of the tibialis *posticus* and flexor communis rest against it as they pass forward. The external lateral ligament consists of three slips, the posterior one of which is attached to the astragalus, close to where it is grooved for the tendon of the flexor proprius pollicis; the anterior slip is attached to the front of the astragalus, the middle one to a tubercle on the outer side of the calcis, and against this last the tendons of the peroneus longus and brevis are placed. The anterior ligament is thin, and extends from the tibia to the astragalus. In front of the ankle-joint the tendons of the tibialis anticus and of the extensor proprius pollicis, the sheath containing the anterior tibial artery and venæ comites, the anterior tibial nerve, the extensor communis digitorum, and the peroneus tertius, lie in the order named, from within outwards, held in their relative positions by the anterior annular ligament, which extends between the two malleoli. The tibialis posticus, which in the leg lies external to the flexor communis, is placed just to its inner side behind the inner malleolus, and in the same sheath of the annular ligament, which extends from the malleolus to the inner side of the great tuberosity of the os calcis. Behind the outer malleolus lie the tendons of the peroneus longus and brevis, the latter being closest to the bone: they are held in their places by the external annular ligament. The anterior and posterior tibial arteries, with the branches of the peroneal, supply the joint freely. Its nerves are the anterior tibial, and the long saphenous.

PART III.—SURGERY.

MECHANICAL INJURIES produce *bruises* and *wounds* of soft parts,—*dislocations* and *fractures* of bones.

Bruises cause laceration of the bloodvessels and nerves, and therefore extravasation of blood and diminution of nervous energy; but the amount of injury that is sustained by muscular, tendinous, and cellular tissue, is very difficult to estimate. There can be no doubt, however, that a severe bruise diminishes the vitality of all soft parts, and renders them less able to withstand the pressure of the inflammatory effusion, which is almost certain to occur.

Swelling and ecchymosis are the constant results of a bruise; but suppuration, and even mortification, are not by any means unlikely to follow.

Cold applications, which serve at once to stop extravasation, and to diminish the chance of excessive exudation, ought to be used at first; but if inflammation be inevitable, then warm fomentations ought to be substituted for these.

Wounds are either incised, punctured, lacerated, or contused; and of these the incised are, under ordinary circumstances, least dangerous.

Punctured wounds demand the utmost attention, both on account of the hœmorrhage that may ensue from sources that cannot easily be reached, and on account of the risk of inflammation, which is liable to take place along the course of the wound. A wound of this kind may heal up at once, but it is not likely to do so. The treatment of the hœmorrhage, is obvious enough, namely, to make a free opening for the purpose of ascertaining where the bleeding point is. If suppuration should occur, then also a free incision will be required for permitting the escape of the matter which has collected. If the matter be not allowed to escape, then there will be very serious risk of purulent infiltration throughout the areolar tissue, and under cover of dense fascias, thereby producing diffuse abscess.

Lacerated wounds often heal badly, because their edges cannot be nicely fitted to one another.

The greatest care must be taken to remove all irritating matter that may have become lodged in the wound. *Contused wounds* like bruises are more apt than the others to be followed by sloughing.

In the treatment of wounds in general, two great principles are to be kept in mind; first, to stop the hœmorrhage completely, either by a compress applied directly to the bleeding point, or by a ligature tied round the bleeding vessel; second, to hinder any accumulation of the inflammatory products, and especially to make certain that no accumulation take place under fascias. The evil may be bad enough when its extent is clearly ascertained, but it will be a great deal worse if concealed from view. Tepid water dressing is admirably suited for almost all cases.

Gun-shot wounds having to a certain degree the characters both of lacerated and contused wounds, are very dangerous; and although wonderful cases of recovery from very aggravated wounds of this description have been chronicled, yet such, if true, must be looked upon as rare exceptions; for the wounds in general are very difficult to treat, and recovery from them very slow.

DISLOCATIONS.—When a surgeon, presuming

upon the knowledge which he supposes himself to possess, because he *is* a surgeon, carelessly examines a dislocated joint, makes an egregious blunder, and finds himself sneered at by a mere bone-setter, then he will be in a position to feel the truth of the following remark; namely, that no amount of theoretical knowledge will avail for the diagnosis of a dislocation, unless coupled with considerable clinical experience, together with a perfect knowledge of the *natural* shape and appearance of the human body. The truth is, that as bone-setters devote themselves entirely to setting bones, and owe all their experience to actual manipulation, they are actually in a better position with regard to this particular department, than many surgeons.

Such dislocations as those of the shoulder and hip-joint are accompanied by such obvious distortion, that scarcely any one who may take the trouble to compare the injured with the uninjured side, could fail to detect the nature of the derangement. But the slight displacements that sometimes occur in the bones of the wrist, tarsus, &c. are extremely difficult of detection.

The vertebræ are very rarely dislocated, and when they are, they cannot in general be replaced.

The injury that can produce such displacement will very likely destroy the patient altogether. The same observations apply to dislocation of the ribs from the vertebræ.

Dislocation of the lower jaw may be readily produced by a slight blow on the chin during yawning. Considering the way in which the dislocation is produced, its treatment will be pretty obvious. Wrap a thick towel round the thumbs, place them upon the molar teeth of the lower jaw, and using them as fulcra, pull up the chin, and at the same time push backwards the entire jaw. But take care not to get the thumbs bitten, as the muscles of mastication are wonderfully strong.

If the inner extremity of the clavicle be thrown either in front of or behind the first bone of the sternum, the bracing back the shoulders very powerfully will do all that can be done. If the dislocated extremity should press upon the trachea, so as to interfere greatly with respiration, then it may require to be excised.

Dislocation of its outer extremity upon the acromion process will require replacement and retention by a pad, but it is by no means easily retained.

The head of the humerus may be thrown back upon the dorsum of the scapula, downwards into the axilla, forwards under the pectoralis major, or may rest upon the coracoid process of the scapula. In the first case the elbow lies rather forwards and outwards. In the second case the elbow is simply tilted outwards. In the third and fourth, the elbow may be thrown backwards and outwards. But in all of them the edge of the acromion process is more distinctly felt, and in the second there is distinct lengthening of the arm, that is to say, the elbow lies opposite a lower part of the chest than usual. But the head of the humerus does not always take exactly the same position in each of the four dislocations above mentioned; for, according to the amount and the direction of the dislocating force, the soft parts may be torn and the muscles separated from the bones to which they are held, in a variable degree. Especially in dislocation into the axilla very severe pain is felt from pressure upon the brachial plexus, and there is often a good deal of swelling, not only from extravasation of blood but also from inflammatory effusion. Of course the head of the bone will be felt in the place into which it has been thrown; but a very little reflection will convince any one who may choose to exercise his judgment, that the changes in position are just what might have been expected. Yet the swelling, the rigidity and tension of the muscles, and the great pain complained of during manipulation, do tend to confuse one about the position of the dislocated bone. But in every case of suspected dislocation of the shoulder-joint, always insert the fingers below the acromion, and observe how the limb hangs.

In reducing the dislocation, the best plan is to pull the limb in the same direction in which it lies. Chloroform may, as usual, be employed for the purpose of diminishing muscular tension. Several ways have been proposed for effecting reduction of dislocation into the axilla, such as bending the limb over the knee, which is placed high up in the axilla, placing the heel in the axilla, and at the same time pulling at the arm of the affected side, or using a counter extending pad for the same purpose. But this, as well as the heel or the knee, is employed merely as a fulcrum upon which the bone is forced to move, and whereby it is tilted outwards from its position. Atrophy of the deltoid muscle, from laceration of the circumflex nerve, is by no means rare.

Dislocation of the elbow-joint almost never occurs, unless as the result of injury that has at the same time caused fracture either of the coronoid or olecranon process of the ulna; and in such cases, having made perfectly certain that there is not fracture at the lower part of the humerus, the best plan is, first, to replace the ulna in its proper position with respect to the humerus, and then to keep the fore-arm at right angles to the upper arm if there be fracture of the coronoid, but to keep the arm extended to its full length if there be fracture of the olecranon. The reason of these precautions is too obvious to need comment.

When the head of the radius is dislocated from the ulna, or more properly, from the orbicular ligament that surrounds it, then it may lie either behind or in front of the ulna—if in the former situation, its presence will be easily detected, but if in the latter, then in general, whenever the arm is attempted to be flexed, the head of the radius catches suddenly, sometimes with a smart snap against the lower extremity of the humerus. Now, although it may be easily replaced, it will not be so easily retained in its proper position; for the same laxity of parts that originally permitted the dislocation to occur, will scarcely prevent its repetition.

The wrist-joint may be dislocated—that is to say, the wrist *en masse* may be tilted out from its articulation with the lower extremity of the radius, and under surface of the triangular ligament of the ulna: for it will be remembered that the radius articulates with the scaphoid and semilunar, whereas the triangular fibrous plate separates the lower extremity of the ulna from the wrist-joint, and articulates with the internal cuneiform bone. This dislocation, although once reduced, may, like others, be apt to recur; but its reduction never presents such difficulties as are experienced in reducing dislocation of the first phalanx of the thumb upwards, upon its metacarpal bone. Dislocation of the thumb is rendered difficult, not only from the circumstance that there are the tendons of six muscles surrounding the joint, but that one of the lateral ligaments of the articulation slips between the articular surfaces, and from this position it is scarcely possible to dislodge it. If it is to be reduced, it will be more by pressure than by actual pulling. Every way must be tried, and section of the lateral ligament may as well be performed in the event of failure by other means, inasmuch as the joint will be unseemly, and scarcely more useful, if left *in statu quo*.

Dislocation of the bones constituting the pelvis is very rare, and when it does happen, is generally caused by a waggon-wheel passing across the pelvis. One os innominatum has in this way been disarticulated from the sacrum; and when it is remembered how very strong the posterior sacro-iliac ligaments are, it will be easily understood that the force necessary for producing such disjunction will in all likelihood have also lacerated some of the pelvic viscera. Cases of this kind almost never recover. The bones are not so difficult to replace as might be imagined; because, as they are surrounded by muscles that restrain them, they cannot be far separated from one another, unless by some force that would crush the pelvis to atoms. The displacement may usually be made out by examination per rectum, and in every case it is proper to introduce a catheter into the bladder, to obviate as far as possible the chance of urine being extravasated. A broad bandage round the pelvis, retention of the catheter, perfect rest, and a sharp look-out for symptoms of inflammation, will constitute the treatment.

The head of the femur may be dislocated upwards on the dorsum of the ilium under the gluteus minimus; backwards into the great ischiatic notch, and resting on the pyriformis; downwards into the foramen ovale, and resting on the external obturator; and forwards on the front of the pubis, resting on the pectineus. The toes are turned inwards in the first two cases, and the limb is shortened: the toes point straight forward in the third case, and the limb is lengthened: the toes are turned outwards in the last case, and the limb is shortened.

In dislocation into the ischiatic notch the shortening is three-quarters of an inch to an inch. The great toe of the affected side rests upon the great toe of the opposite foot; and the limb is so peculiarly bent with respect to the body, that on laying the patient horizontally, and attempting to straighten out the limb, the back is thrown into a curve; and when the trunk is flattened the limb rises up. Extension may be made across the middle of the opposite thigh, counter-extension by means of a pad and belt being made in nearly the opposite direction.

Dislocation upon the dorsum ilii is attended by shortening to the extent of a couple of inches or more; the great toe of the affected side rests upon the dorsum of the opposite foot, and the one knee is advanced in front of the other. Extension and counter-extension in a line across the knee of the sound limb, will generally succeed in restoring the femur to the acetabulum. This and the preceding dislocations are generally caused by force applied to the trunk of the body while bent forward upon the extremities in the stooping posture.

Dislocation into the foramen ovale causes lengthening to the extent of about two inches, and is usually caused by the application of great force to the pelvis whilst the body is in a stooping posture, and the limbs separated from one another. The treatment required in this case is peculiar. Counter extension is made across the pelvis, and the lacque is attached partly around the upper part of the affected thigh, partly into the counter extending belt, and in this way the head of the bone is carried upwards and outwards; but the greatest care must be taken to keep the ankle of the affected limb below the level of the opposite one, and at the same time to pull it towards the opposite side.

FRACTURES are distinguished from dislocations, in general, by the much greater ease with which the surgeon can move the displaced parts, and especially in the case of long bones, by the circumstance of the shaft being easily rotated, independently of the cavity with which the bone articulates.

In regard to the clavicle, it is to be particularly remarked that when it is fractured *between* the attachments of the coraco-clavicular and coraco-humeral ligaments, the shoulder does *not* fall, although when fractured about the middle there is always great depression of the shoulder, often accompanied by much projection of the part still attached to the sternum. The treatment required in this case, is to fix the scapulæ with a figure of eight bandage, and to square the shoulders by slinging the forearm, and binding the elbow backwards and to the side. Although some surgeons have confidently spoken about supporting the head of the humerus by a large pad in the axilla, yet, whenever a pad is placed sufficiently high to be useful, it causes too much pain to be suffered by the patient.

When the neck of the scapula is broken off, the limb falls by its own weight, and the elbow, as in dislocation, is tilted outwards. The parts are easily replaced; but it is necessary to be careful not to use a pad, as it would tend to separate the arm from the side. Keeping up the shoulder

by slinging the forearm is all that is really
quired.

As a fracture of the anatomical neck of
humerus is always attended by dislocation i
the axilla, the symptoms strongly resemble th
of ordinary dislocation ; but the case is dis
guished by the ease with which the head of
humerus, minus its articulating surface, is repla
The treatment is just to replace it, and maint
it *in situ*, by slinging the forearm. There is
use of trying to dislodge the articular part fi
the axilla, in which, after a short time, it beco
encysted. The broken head of the humerus s
accommodates itself wonderfully well to the glen
cavity.

When the humerus is broken through just
low the tuberosity, that is, at its surgical ne
the upper fragment is tilted outwards by the c
sular muscles. The upper extremity of the lo
and larger fragment is pulled upwards and
wards, while the elbow is tilted outwards by
deltoid. The projecting upper fragment is to
pulled into its place by a spica bandage, appl
over a pad, and extending across the oppo
shoulder, and into the opposite axilla. The lo
part of the bone is to be brought down

squared with the upper, by being held from the chest by a pad placed low down in the axilla, and by a splint placed along the outer side of the arm, extending above the shoulder, and below the elbow. The forearm had better be slung, and the arm bound to the side by a proper bandage.

As the humerus is well surrounded by muscles, fracture about its middle is attended with little displacement. Perfect rest, with the use of a splint, are quite enough.

In oblique fracture just above the condyles, either from behind downwards and forwards, or from before downwards and backwards, the treatment is more difficult. A rectangular splint, with a weight hung to the elbow, is the best plan of treatment. The diagnosis of this fracture is of course by measurement of the distance between the acromion process and condyle, and also by observing the position of the condyles.

Fracture of the radius may be diagnosed almost at once by the pronation of the hand, which is nearly certain to exist in this case. If the forearm be held at one part, the hand may yet be moved independently, and it cannot be too carefully remembered that it is *independent mobility* of parts which should only move in one mass that characterizes this and indeed almost every fracture.

Fracture of the ulna may be more easily made out, as the ulna is subcutaneous in its whole extent. Yet, if it be not nipped across, but broken in a slanting manner, the crepitus may not distinguish it. But it is a great matter that when fracture is very difficult to make out it is also in general of very little consequence, and requires only rest to effect a cure. When both bones of the forearm are fractured, it is very difficult to obtain a good cure, for the pronators pull the bones together very powerfully. If the patient .be thin, interosseous pads placed both in front and behind may perhaps be useful, but in stout persons they are of very little use. All fractures of the forearm may be treated by placing it held by suitable splints at right angles to the arm, and in the middle state between pronation and supination. In the case of the radius it is as well to allow the thumb to hang down.

Fractures of the ribs will be accompanied by emphysema of the cellular tissue, which communicates a peculiar crackling feeling to the fingers. Pneumothorax may also exist, and this will be indicated by great difficulty of breathing. Under ordinary circumstances, a broad bandage applied round the chest will suffice; but where there is great dyspnœa, bloodletting will be required.

Injuries of the Spine are highly dangerous, whether they produce fracture or not. As the function of the spinal cord is a motor one, either paralysis or convulsions may be expected to result from any lesion of it. But the nearer to the brain the injury is, the more urgent will be the danger to life. For example, injury of the spinal cord at its lower part may cause paralysis of the lower extremities; but injury at its upper part may so affect respiration as to destroy life from that cause alone.

One of the first symptoms observed in spinal injury is the ammoniacal state of the urine, which is in a great measure owing to paralysis of the bladder; and therefore, in every case of suspected spinal injury, the catheter should be introduced, if water has not been passed within a reasonable time after the accident. Priapism is also a very characteristic as well as a very distressing symptom in spinal injury.

Considering the way in which the spinal column is surrounded by its muscles, it will be very difficult to diagnose a fracture in any of the vertebræ that compose it, unless the displacement be very serious indeed. Where the vertebræ have been crushed in by powerful mechanical injury, the speedy death of the patient will generally render all interference unnecessary. But where the injury has not been so severe, a careful examination of the spinous processes, and comparison of their relative positions, is all that can be done to ascertain the nature or extent of the injury. And here it may just be remarked, in regard to fractures in general, that the muscles give excellent support to fractured bones; and that it is more especially the duty of the surgeon to place fractured parts under favourable circumstances for being united, than to attempt to force their reunion by a vast apparatus of splints. In cases of fractured spine, for example, a long iron splint has been recommended for the purpose of keeping the spine immoveable; but if such be used, the very greatest care must be taken that the patient do not receive most serious injury by its employment. Perfect rest is, of course, quite imperative, and a hard level bed is about the best that can be employed. It should be a proper fracture bed, so constructed that the patient may have evacuation of his bowels without requiring to rise. It must be remembered that the anterior part of the spinal cord is frequently more injured than the posterior, and therefore, that the cord may for a time lose its power of conducting volition *from* the brain, although it may still retain its power of conducting impressions to the brain ; and consequently there may be the most excruciating pain felt when no voluntary motor power exists in the pained parts : and further, the constant irritation which may result from injury may produce an extremely excitable state of the cord, sufficient to render the patient unusually sensible to pain. The utmost vigilance must always be exercised to detect the first commencement of inflammatory symptoms ; and calomel and opium, with or without bloodletting, should be employed as circumstances may require.

Fracture of the pelvis is generally caused by a fall from a height, and as laceration of the urethra, if not of the pelvic viscera, is highly probable, the first thing is to introduce a catheter into the bladder, put a broad bandage round the pelvis, and send the patient to bed. The after treatment will depend upon circumstances.

Fracture of the neck of the femur within the capsule is generally characterized by eversion of the toes and shortening of the limb ; but the position of the limb, as also the degree of shortenin will be greatly influenced by the direction of t fracture, and the extent to which the perioste and capsule are torn. In almost all cases, ho ever, the shaft may be made to rotate, indepe dently of the acetabulum. Where the ba part of the great trochanter, and the whole of t small one, are broken off, then the toes may turned *inwards* by the action of the anterior fib of the gluteus medius, along with the tensor v ginæ femoris. In all cases of fracture of the mur except one, the long splint may be consider as the proper treatment. It is wrapped in sheet, applied along the outside of the limb, a fastened to the foot by a proper bandage. handkerchief is then passed under the perineu and its ends are brought through two holes in t upper end of the splint, which reaches at least the false ribs. Now, remembering that the fo is fixed to the splint, it is only necessary, by mea of the handkerchief, to shorten the distance b tween the perineum and the upper end of t splint, to lengthen the limb to its full extent, a to keep it there. The last fold of the sheet which the splint is wrapt should include the lim and so bind it and the splint together.

The exceptional case in which the long spl must not be used, is that of fracture just above the condyles, extending obliquely from behind downwards and forwards, for the gastrocnemius holds the lower fragment so much backwards, that the double-inclined plane must be used in order to relax it.

When the foot is turned forcibly outwards, then most likely the fibula is broken across in its lower fourth, and at the same time the fibula is dislocated either inwards or forwards. In the former case, a pad and a splint with an aperture in it, to accommodate the inner malleolus, is to be placed along the inner side of the leg, and the foot bound inwards to it; and in this way the fracture is set at the same time that the dislocation is reduced. If the tibia should be thrown forward, the splint must be made to fit upon the dorsum of the foot, and placed with a pad along the front of the leg. The heel is then bound forward to it. Where the tibia is fractured, and the fibula displaced outwards, which, from the strength of the ligaments, is very rare, then the pad and splint must be placed along the outer side of the limb, the foot being bound to it as in the former case.

In falling from a height, persons sometimes fall

on their heels and chuck out the astrag
is found lying on the dorsum of the foo
as well be excised at once, for replace
of the question.

In regard to all compound fracture
locations, it is necessary to bear in m
there be much risk of mortification tal
then if it be a limb, amputation is th
source.

DISEASES OF JOINTS.—When acute
tion seizes the structures of a joint, the
treatment is required as for acute in
elsewhere. General bloodletting, c
opium, leeching, and warm fomentation
the available remedies in such cases.

Chronic diseases of joints, among
be reckoned caries, chronic synovitis
cartilage, loose cartilages, and sev
affections, are to be treated accordin
various peculiarities.

White swelling of the knee-joint, th
a swelling which is not attended by
degree of redness, may arise from three
namely, ulceration of the cartilages,
flammation of the ends of the bones, o
degeneration of the synovial membran

first two the pain is very severe, confined to one spot in the ulcer of cartilage, but diffused in the chronic inflammation. In the gelatinous degeneration there is no pain even upon pressure. The swelling extends as far as the synovial membrane, and is soft and doughy.

The treatment is the same for ulceration of cartilage and chronic inflammation of the bones, namely, the actual cautery applied on each side of the joint, and perfect rest of the limb. The gelatinous degeneration is perhaps best treated by covering the joint with strips of lint, covered with a mixture of camphorated mercurial ointment with litharge plaster; then applying a bandage from the toes upwards, and making it press rather firmly upon the joint; lastly, applying a splint, and maintaining the limb at perfect rest. Chronic synovitis may be advantageously treated in the same way.

CARIES—*Disease of the Spine.* Caries may take place in the bodies of the vertebræ, either as the result of tubercular deposit in the cancellated texture, or from causes that cannot be ascertained. There is no doubt that persons may over exert themselves, and so lay the foundation of disease that they cannot trace to its first origin. The upper cervical vertebræ may be affected; if so, the care that the patient takes in holding his head, apparently lest it should fall off, is very striking, and arises from the intense pain that the slightest twist in the neck is sure to cause him. The degree of muscular palsy, torpidity of the bowels, &c., will be influenced by the severity of the disease. If the transverse ligament of the atlas should ulcerate through, then the odontoid process, by its pressure on the medulla, causes instant death.

Means should be taken to keep the head perfectly steady, and as the actual cautery appears to be the most effective counter-irritant, it should be applied on each side of the mesial line behind the affected vertebræ, and these may be almost at once detected by tapping along the spinous processes. The patient winces the moment the affected vertebra is touched. No doubt, in cases of spinal irritation, intense sensibility may be manifested, but if the patient's attention be drawn away, considerable irritation may be applied with out a murmur.

If abscesses should form, then they had bett not be opened until the skin is nearly perforat although there is really some doubt about t correctness of this practice. If it be suspect from the occurrence of difficulty in breathing and swallowing, that the purulent matter, by its pressure on the spinal cord, is the cause of these symptoms, then, as the patient's case cannot be rendered more desperate, and may perhaps be improved, the matter ought, by all means, to be let out.

If the lower dorsal, or upper lumbar vertebræ be affected, then, again, the patient's gait is so remarkable that the case can hardly be mistaken. He walks with the most intensely military erectness, while, at the same time, the uncertainty of his steps cannot escape notice. The slightest twist gives him excruciating pain, and so does the slightest percussion applied to his back. Generally, also, there is severe pain shooting round the origin of the diaphragm, into the abdomen, and also in the paralysed limbs,—all this arising, of course, not from any cause existing in these parts, but from the irritation occasioned in the spinal cord by the diseased vertebræ. After a time he becomes unable to walk, and is confined to bed; and this is owing partly to the loss of nervous power, partly to deficient nourishment; for the appetite generally diminishes as the disease proceeds, and very often nausea and vomiting occur without any better cause than the spinal disease. As might be expected, paralysis of the bladder ultimately ensues, and the urine becomes ammoniacal. An abscess generally forms and points in one of two directions, either above the back part of the crest of the ilium, when it is called Lumbar Abscess, or in the groin, when it is called Psoas Abscess,—these names being used to express the direction in which it is understood that the matter has passed. In the former case, the lower dorsal vertebræ may be affected, and the matter comes down between the layers of the lumbar fascia; in the latter case, the upper lumbar are affected, and the matter passes down in the sheath of the psoas. It is better not to meddle with the abscesses very early; but when the skin is nearly cut through, it may be as well then to puncture them. The spine gradually bends, because the bodies of the vertebræ crumble down, and a sharp angular projection is formed, on account of which appearance the disease has been termed *acute* curvature.

The affection occurs most frequently in scrofulous children from eight to fourteen years of age; and they have a much better chance of surviving the disease than adults have. The treatment obviously requires to be moderately tonic from the very commencement. The employment of cod-liver oil and a nutritious diet, while the patient is kept in a pure atmosphere, may serve for the constitutional treatment. The actual cautery applied over the affected vertebræ, will suffice for the local treatment. But as each patient may have something peculiar in his own constitution, every care must be taken to modify the treatment according to his circumstances.

Now, the same observations that apply to caries of the vertebræ apply equally to caries in any other position; only with this difference, that in some situations a great deal may be done to afford relief, by excising the diseased bone. But it is only when the caries is not of a scorfulous nature that excision is of any avail.

Morbus coxarius, or hip-joint disease, also occurs most frequently in children, and almost the first symptom of it is, that the child drags the limb after him in running or walking. After a time there is great pain felt in standing on the affected limb; but the pain is referred chiefly to the knee, and extends down the inner side of the thigh and across the front of the knee from within outwards, being thus distinguished from the pain of Sciatica, which extends down the outer side of the thigh. The foot of the affected side is advanced in front of the other, and there is lengthening of the limb either real or apparent—it is sometimes difficult to say which. As the disease goes on, the neck of the femur may be broken up, and as the surrounding muscles still continue to act, the limb is very decidedly shortened,—the fold of the hip is flattened, and the patient rests on the toes of the affected side. An abscess forms usually outside the great trochanter, and may be opened when it decidedly points. The chronic inflammation that causes morbus coxarius is usually not preceded by tubercular deposit; and although either the cartilaginous, the osseous, or the synovial structures may be affected, yet in this case the disease is thought to be merely chronic inflammation, affecting the head and neck of the femur, and generally also the acetabulum to a great degree. The utility of excision of the affected parts is still doubtful. One case certainly has succeeded, and two others have been reported as successful. If it is to be useful, it is only in those cases where the acetabulum is but slightly affected. If the case be got at its first commencement, perfect rest in bed, maintained by the use of the long splint, along with the application of the actual cautery between the trochanter and tuberosity of the ischium, may be found of some avail. But, in the advanced stage, although it will be proper to employ all the remedies that are most effective as counter-irritants, yet there will be little use of annoying the patient by fixing him up with the long splint.

It should always be recollected, that if patients are to recover, it will be fully as much owing to judicious regulation of diet, as to any course of alterative medicines, or local applications.

In regard to morbus coxarius, it is to be particularly observed that the ordinary modes of diagnosis may fail in detecting the disease. Although striking the heel when the patient is in a horizontal posture, or percussion applied over the trochanter, will generally produce intense pain in the hip-joint, affecting also the knee, yet these symptoms will not be elicited in cases where only the lower part of the acetabulum is diseased; for in these cases the patient is able not only to rest comfortably on the affected limb, but even to hop upon it, although he may have all the other symptoms of the disease, and may suffer severe pain whenever he allows the limb to hang.

Disease of the shoulder-joint.—As there are merely the ordinary symptoms in caries of this joint, no particular observation is called for. When its presence is suspected, the ordinary means must be used for its removal, and if it become established, then the head of the humerus must be sawn off, and the glenoid cavity scooped out. Great care must be taken, however, not to remove the layer of soft lymph that surrounds the diseased bone, under the false impression that it also is diseased, for this is the material that has been thrown out for the repair of the tissue, and which would have succeeded in curing the disease had it been any thing less obstinate than caries. The muscles find new attachments for themselves, and the limb may afterwards be wonderfully useful.

The same sort of treatment may be employed in cases where the elbow-joint is affected. It matters little what form of incision be employed, providing it be made at the back of the joint, and so as not to endanger the ulnar and inferior profunda arteries, and the ulnar nerve. The sigmoid cavities of the ulna are to be scooped out, the head of the radius and condyles of the humerus to be sawn off, and the parts readjusted. The fore-arm is to be retained nearly at right angles during the progress of cure, as that position will be found most conducive to the comfort of the patient. The muscles, as usual, form new attachments, and a considerable power of flexion may be regained by the joint.

Disease of the ankle-joint and Bones of the Foot.—When the metatarsal bones are affected with caries, then Hey's operation may be performed, although it is scarcely useful to do so. Incisions must be made, such as will permit the disarticulation of the metatarsal bones, and perhaps also of the internal cuneiform, but the operation is difficult. Chopart's operation is a better one, and consists in the removal of all the bones of the foot, except the astragalus and calcis. The middle distance between the tuberosity of the scaphoid and inner malleolus, and between the base of the metatarsal bone of the little toe and the outer malleolus, constitute the extreme points of the curved incision made in the dorsum of the foot. The articulation between the calcis and cuboid, and between the astragalus and scaphoid is so nearly transverse, that the division is made at once. The flap is taken from the sole of the foot, and an excellent stump may be formed. But the same misfortune that affects Hey's operation, also affects Chopart's. The disease is apt to extend to the bones that yet remain, so that the calcis and astragalus also require removal. Professor Syme's operation may then be performed, which consists in sawing through the lower extremities of the tibia and fibula in such a manner as to remove only the malleoli and the cartilage of the lower extremity of the tibia, and obtaining a flap from the heel.

Caries of the bones that form the knee-joint cannot be treated by excision with any hope of success.

INFLAMMATION. — When inflammation seizes the skin, it may be like inflammation in any other part, either limited or diffuse. When limited, it gives rise to various forms of skin disease: when diffuse, it constitutes erysipelas.

There are two kinds of erysipelas, independent of the slight variety called erythema, which is strictly limited to the true skin; and these are, simple and phlegmonous. In reality, however, they differ from one another only in extent; the simple affecting the skin and subcutaneous areolar tissue; the phlegmonous extending deeply in the course of the fascias, and in a manner dissecting up the limb that it attacks. Why the one should be limited to the surface, and the other should extend deeply, cannot be ascertained. The redness is deeper in the phlegmonous than in the simple variety, but the swelling very much greater, and the inflammatory action more intense; yet the danger to life is often quite as great in the one as in the other. Indeed, the disposition to spread, which so characterizes the simple erysipelas, is always associated with a debilitated state of the system; or at all events, if it does occur in a strong system, there must have been some poisonous influence acting upon it.

The treatment is, to puncture the surface in the simple variety, but to make rather deep incisions in the phlegmonous. Although the peculiar state of system cannot be at once remedied, the incisions have at least the good effect of allowing the acrid matter which always exists in such cases to escape. Support of the system by wine, and, if the patient can take it, also nutritious diet, is of paramount importance. Chlorate of potash, taken several times a-day, is said to have an excellent effect in typhoid diseases: and as erysipelas, and indeed all inflammations that have a tendency to become diffuse, are typhoid, this remedy ough certainly to be exhibited.

SKIN DISEASES. — These are, Exanthemata Vesiculæ, Pustulæ, Papulæ, Squamæ, Tuberculæ and Maculæ.

The *Exanthemata* include Erythema, in which there is a slight continuous redness of the skin, in patches of various shapes and sizes; Roseola, exhibiting circumscribed rose-red patches, which are either circular, serrated, or annular; and Urticaria, in which there are elevated red patches of an irregular shape, with their centres often paler than the surrounding skin.

Vesiculæ include Eczema, Herpes, Scabies, and Pemphigus. Eczema consists of patches of very minute vesicles lying on a bright red surface, presenting a shining appearance, and yielding fluid that dries into a scaly or branny-looking crust. Herpes is composed of clusters of vesicles that vary in size from a millet seed to that of a pea; these clusters are surrounded by a bright red areola. The vesicles yield a fluid which dries into a thin crus and drops off between the eighth and fifteenth days Scabies, or itch, consists of isolated vesicles having rather a conical shape usually seated between th fingers, and on the flexor surfaces of the arms and abdomen, but never on the face. Pemphigus is characterized by large vesicles or bullæ, which are surrounded by an erythematous circle, and yield a fluid that forms a laminated crust. When chronic, and appearing in successive crops, the disease is called Pompholyx.

Pustulæ include Impetigo, consisting of small pustules that usually occur in groups, the matter from which forms an elevated crust; Ecthyma, consisting of large isolated pustules, depressed in the centre and leaving a cicatrix; Acne, consisting of isolated pustules placed on a hardened base, forming and disappearing slowly, but occurring only on the face and shoulders; and Rupia, consisting of large pustules, followed by thick prominent crusts, and causing ulcerations of various depths.

Papulæ include Lichen, consisting of minute papulæ that occur in clusters or patches; and Prurigo, consisting of larger and isolated papulæ, usually seated on the exterior surfaces of the body.

Squamæ include Psoriasis, in which there are whitish laminated scales slightly raised above the reddened surface of the skin; Pityriasis, consisting of very minute scales like bran, seated on a reddened surface; Ichthyosis, in which there is hardening of the epidermis and formation of square or angular plates not seated on a reddened surface.

Tuberculæ include Lepra Tuberculosa, in which there are tubercles of various sizes preceded by erythema and increased sensibility of the skin, followed by ulceration of their summits; Lupus, characterized by hardening or tubercular swelling of the skin, which sometimes does and sometimes does not ulcerate: if it does, then the ulceration may commence either at the summit or base of the tubercles, and may extend in the form of a circle, constituting a phagedænic ulcer; lastly, Molluscum, consisting of pedunculated, globular, or flattish tubercles, occurring in groups, not accompanied by erythema or increased sensibility: they are filled with atheromatous matter.

Maculæ include Lentigo or Freckle, which displays itself in brownish spots on the face, neck, or hands; Ephelis, consisting of brownish patches, with slight desquamation of the cuticle; Nævi or Moles, being differently coloured and shaped elevated spots, which are congenital; Purpura, which is characterized by red or claret-coloured spots, not disappearing under pressure.

Dermatozoa are minute animals existing in several of the previously mentioned affections, but not altering their appearances.

Dermatophytæ, are minute plants, including Favus, consisting of bright yellow crusts surrounding single hairs which agglomerate to form crusts, having a mousey smell; and Mentagra, which is a yellowish dry crust affecting the hair follicles of the beard.

Inflammation of mucous membrane is either croupy, catarrhal, or ulcerative; but in all cases the membrane first becomes dry on the surface, and thickened by serous effusion into its submucous tissue. The existence of ulceration is not always easy to determine, and opinions differ in regard to what really constitutes an ulcer of mucous membrane. The term, however, is applied to simple removal of the epithelium, to perforation of the basement membrane, or even to considerable excavation; and it will not be forgotten that the muscular, and even the serous coats of the hollow viscera, may be perforated.

Papular, vesicular, and pustular eruptions, may occur in mucous membranes, and, indeed, the venereal pustule passes through the two first of these. When a pustule is quite perfect, the basement membrane is still unbroken, for the purulent matter accumulates between the epithelium and the basement membrane: but this may be perforated by ulceration after the pus has been discharged. Prurigo and scabies have been observed on the cervix uteri, and small-pox pustules occur not only in the mouth, but in nearly the whole intestinal canal.

The ulcers of mucous membrane vary in their appearance according to the health of the patient, and the intensity of the local action.

Gangrene may also occur in mucous membrane, and of this the sloughs upon the throat in scarlatina maligna are sufficient examples.

The exact change that occurs in serous membrane, when it becomes inflamed, has not been ascertained. Some think that the surface becomes quite dry, others imagine that lymph is exuded and immediately solidifies. When the layers of a serous membrane are glued together, then it is possible that the lymph may be reabsorbed, as has happened in the case of a man who attempted to destroy himself on several successive occasions, by stabbing himself in the abdomen. The lymph surrounding the recent wounds was quite firm, but that corresponding to the early injuries was so completely absorbed, that the peritonœum had regained its smoothness; and it was only by ascertaining the presence of a cicatrix that the former existence of lymph could be suspected.

Only two varieties of inflammation occur on serous membranes, namely, the plastic and the purulent. The plastic exudation may not always become entirely developed into tissue, because, when a copious effusion takes place, the fibrine is deposited upon the wall of the serous cavity, while the serum occupies the cavity itself. Capillaries that form in the soft lymph which is deposited upon the membrane, often appear to absorb the serum with great rapidity; but when it is said that the *fibrine* coagulates, or is deposited, it must not be imagined that it is *only* the fibrine which become solidified; for in reality, the albumen and oil existing in the liquor sanguinis are sufficient of themselves to constitute a tissue: and a little reflection upon the distinctions ascertained to exist between albumen and fibrine, will sufficiently demonstrate the impossibility of distinguishing the one from the other. No doubt it is a cardinal fact, that the lymph exuded at the commencement of an inflammatory attack has more disposition to solidify, than that which is poured out in the more advanced stages of the disease; but effusions may be found in the pleura and elsewhere, which, although semifluid as long as they remain in the cavity, solidify as soon as they get out of it—in fact, as soon as they come in contact with some solid substance. So that when it is pointedly stated that the fibrine is deposited upon the surface of the membrane, while the serum remains in the sac, it is as well to know that perhaps there may be no truth in the statement; but that the portion of the exudation in contact with the membrane solidified merely because it was in contact with the membrane. It is well known that the liquor sanguinis, not the corpuscles, is the coagulable part of the blood; and as blood when kept in mass, and free from contact of air, remains uncoagulated, so may the liquor sanguinis behave just like blood. It will be proper just to glance at the agents accelerating or retarding the coagulation of blood.

When gangrene takes place on a serous membrane, there is greater depression of the vita powers than when a mucous membrane, or ir deed any other tissue, is so destroyed.

When intestinal or other matters escape ir serous cavities, death is sometimes so rapid, that the fatal event can only be explained on the understanding that the peritonœum is very largely supplied with nervous fibres, chiefly ganglionic, which being affected over a great extent of surface, produce the most mortal depression. It is remarkable indeed, that gangrene of a serous membrane exhibits such fearful results as are observed in cases of strangulated hernia, especially when the gangrened part forms a portion of a much larger sac, and when the gangrene is caused by strangulation; for there is no sort of injury, the influence of which will spread more rapidly and more extensively than the pressure of strangulation, unless perhaps that of an extensive burn.

As already stated, inflammation in fibrous membranes seldom results in anything but plastic exudation; and it is also worthy of remark, that the amount of exudation is not great. This is quite in accordance with the sort of nutrition peculiar to this tissue, which, from the nature of its function, ought not to be, and is not active. Suppuration, however, does sometimes occur, but gangrene either never, or almost never does. When lymph is exuded between periosteum and bone, the stretching of the periosteum is very likely attended by some change in its structure, for fibrous tissue is nearly inextensible.

Inflammation in bone, no doubt, may go on to abscess, distinguishable into limited and diffuse; but really diffuse abscess of bone, although perfectly possible, is by no means a very common event. Necrosis, however, is not unlikely to happen in the shaft of a bone; and according to its extent, the dead portion is called an *exfoliation*, when in the form of a thin plate upon the surface, and a *sequestrum*, when of much thicker extent, The peculiar structure of dense bone appears to render the occurrence of necrosis rather easy, for necrosis is really equivalent to mortification in soft tissues; and as the cause of mortification is entire obstruction to circulation, a rapid exudation from the vessels of dense bone would have the effect of entirely preventing its nutrition as its tissue cannot stretch. Limited abscess as the result of acute inflammation, is found in the head of the tibia, but scarcely anywhere else, and requires for its treatment that an opening be made for the exit of the matter, either by the knife or the trephine, whichever may be the most convenient.

Boil is sthenic inflammation of a limited portion of skin and areolar tissue, accompanied by laudable suppuration, and ending in death of the affected tissues. Boils are gregarious: they are conical, with a yellow apex, and a hard, red, painful base. They occur generally on the back, shoulders, hips, and legs. If left to themselves, they burst on the apex; and the treatment consists in accelerating this process by a free incision, to admit of the escape of both the pus and the slough, after which the granulating wound is dressed as usual.

Carbuncle consists in asthenic inflammation of the areolar tissue, which sloughs: the skin is little involved, but becomes slightly gangrenous, and allows a fœtid, sanious pus to ooze out. The swelling is painful, dark, and spongy, and the integument livid and swollen. Carbuncles occur in the same positions as boils, but are solitary. Vesicles form on the skin; and when the cuticle gives way, the sloughy apertures of the integument are disclosed.

The treatment consists in free and early incision in the crucial form, extending beyond the reddened surface, followed by the application of potassa fusa. A poultice is applied till the slough separates, and then water dressing is had recourse to.

Acute Abscess.—Abscess following inflammation has a tendency to point towards the external surface; but when that is distant, or separated from the pus by dense fibrous tissue, it will direct its course to the nearest mucous surface. The symptoms are the ordinary signs of inflammation. The swelling is soft and fluctuating in the centre; external to this, it is hard; and outside of all, the surface is swollen, soft, and pitting. It assumes a conical form, the colour of the pus gradually developing itself in the centre as the integument becomes attenuated. Treatment consists in mitigation of the inflammatory action; favouring the approach of the matter to the surface by poultices; evacuation of it by a free incision; fomentation and rest.

Chronic Abscesses are slowly formed, generally in weak constitutions. They vary greatly in size, and are sometimes very large. When small, discussion should be attempted either by blistering or application of iodine; but if this fail, the abscess should be treated as if acute. When large, it may be treated in the same way, that is, by a free incision to evacuate the purulent contents, after which, two sponges should be applied over the surface, one on each side of the incision, and bound down. By this means the fluids escaping are absorbed and the air prevented from entering. If a trochar be used, great care should be taken to prevent the admission of air.

ULCERS.—Whatever character an ulcer may present at its commencement, or during its course, it must always assume the character of the healing sore previous to cicatrization: and therefore it may be said that there is only one ulcer that tends to heal.

The healthy ulcer is covered with minute bright red conical granulations which are highly sensitive, and bleed when they are injured. The surface is not elevated beyond that of the surrounding skin, which is slightly more vascular than usual, and appears to send inwards a thin pellicle, which is the commencement of the cicatrix. Until covered by its cicatrix, the healthy ulcer has its surface protected by a thin layer of healthy purulent matter: the lymph becomes organized into pus, until the surface is ready to become continuous with that of the skin, and then the lymph becomes organized into the fibrous net-work that constitutes the cicatrix.

John Hunter thought that ulceration was to be considered as a process of absorption, and some first-rate authorities still maintain that the process of granulation, when it appears to fill up a vacuity, does so, not by the formation of new matter as might appear, but by the absorption of the tissue surrounding the granulating surface. Certainly the appearance presented by granulation very strongly resembles the papillary structure of the skin, and when an indolent ulcer turns into a healthy one, it may be supposed, from this theory, that as the unhealthy substance becomes removed from the surface of the wound, the healthy tissue becomes apparent.

Most physiological authorities, however, insist that new tissue is really produced.

Unhealthy Ulcers are constituted either by excessive action, defective action, or peculiar action.

The Irritable Ulcer presents an angry appearance; its surface is covered with small granulations; the edges are fiery; the patient is very irritable. Lunar caustic, slightly applied over the surface and edges, and a pretty strong opiate given to the patient at night, will be sufficient.

The Inflamed Ulcer is an ordinary ulcer with inflammation going on around it.

The Phagedænic Ulcer, spreads rapidly by continuity, but its mode of treatment is by no means easily determined. The noli me tangere is an excellent example of this variety.

The Sloughing Ulcer spreads by contiguity, that is to say, it removes layer after layer of the tissue, and increases rapidly in depth, as seen in the malignant pustula, and in sloughing sore of the penis.

Sloughing Phagedæna is the most rapid of all ulcerations, as is amply exhibited in cancrum oris and in Hospital Gangrene. Some consider that this is best treated by the application of opium, others imagine that it requires the most powerful escharotics.

The ulcers that are prevented from healing by defective action, are only the weak and the indolent ulcer. The first is characterized by the tall, pale, flabby granulations that cover its surface and overhang the bluish congested integument surrounding it. The best treatment for this is the application of a bit of lint (less in diameter than the ulcer) to its surface, and over this a pretty firm bandage, which along with the lint, is to be removed in a few hours, by which time a sufficient degree of stimulus will have been applied. The indolent ulcer is characterized by the absence of granulation on its surface, which is smooth, glassy-looking, and depressed. The edges are thick, sometimes almost cartilaginous. Nothing but powerful stimulus will have any effect here, and therefore a blister should be applied once or oftener, taking care at the same time not to arouse excessive inflammatory action.

In regard to ulcers that are prevented from healing by peculiarity of action, they present every variety of appearance, and their treatment must be regulated by the peculiar state of the system at the time. But it must be always kept in mind, that their character is essentially indolent.

DISEASES OF THE URINARY ORGANS.—It may be stated, in general, that whenever inflammation affects any part of the genito-urinary mucous membrane, pain at the point of the penis is its constant attendant. This, indeed, often constitutes an excellent diagnostic mark in cases of nephritis, pyelitis (inflammation of the pelvis of the kidney) and cystitis; but in no case more than in stone in the bladder.

Nephritis is characterised by pain in the region of the kidney, not increased upon pressure nor upon suddenly rising up from the stooping posture, but especially extending down along the course of the ureters; retraction of the testicle on the affected side, numbness at the upper part of the same thigh, and pain at the point of the penis. The urine is high-coloured, generally scanty, and often mixed with blood. In the advanced stage, purulent matter may also be formed.

It must be here remarked, that as the blood comes either from the kidney itself or from the ureter, it is perfectly *mixed* with the urine; whereas if it come from the bladder, it will generally be clotted, and will be discharged towards the termination of micturition; and if from the urethra, as might be expected, it will precede the urine.

Cystitis, like other inflammatory affections of the mucous membrane lining hollow organs, is accompanied by frequent discharge of the contents of the organ. There is very frequent discharge of urine in small quantities, and this is accompanied by the usual feeling of tension, heat, and pain in the region of the bladder, with pain at the point of the penis. After a time there may be discharge of purulent matter even, although the disease may subside into catarrh of the bladder; and this may be considered as a very chronic inflammation accompanied by discharge of mucus in large quantity, so great, indeed, as often to allow the urine when cool to be poured out in a continuous rope. The mucus is often mixed with a large amount of phosphates.

And here it may be stated, that purulent matter forms a stratum at the lower part of the vessel containing the urine, while mucus is suspended in the urine so as to give it a cloudy appearance.

The microscope will of course furnish a ready means of diagnosis. Acetic acid also will cause the mucus to shrivel into a membrane, but will render the pus rather clearer. It is to be observed moreover, that pus may easily be diffused through the urine by shaking it up, while mucus cannot be well mixed by any amount of agitation.

In cystitis as in irritability of bladder the pain is felt chiefly *before* micturition ; whereas in stone, for a very obvious reason, the pain is felt most severely *after* making water, except in those cases where the calculus is encysted ; and in stricture of the urethra, pain is always most severe *during* micturition.

These distinctions are very important.

Stone in the Bladder is characterised especially by the peculiar difficulty frequently experienced in passing the urine in a continuous stream ; the patient often having to get upon his hands and knees, or to assume other attitudes, in order that the stone may be displaced from the inner orifice of the urethra, over which it is so liable to fall like a valve, and suddenly stop the flow of urine. It is impossible to be quite certain that a stone is present within the bladder, unless it be distinctly felt by a Sound or by a Catheter, and always before operating this test should be applied.

A phosphate of lime calculus causes greatest pain, not only because it is smooth and lies almost perfectly in contact with the mucous membrane, but because it occurs in weak and irritable subjects, who are generally much affected by the presence of disease. The oxalate of lime calculus perhaps causes least pain, because, from its tuberculated form, its points of contact with the mucous membrane are few.

The Urinary Calculi are uric acid, oxalate of lime, phosphate of lime, triple, or, as it should be called, double phosphate, fusible, cystic, and Xanthic oxides ; and to these may be added urate of ammonia and carbonate of lime.

The urinary calculi rarely contain only one of the above substances—most calculi being found to consist of two or more of them.

Uric Acid ($C^{10} H^4 N^4 O^6$) is the most frequent of all calculi. It has an oval shape, a smooth or finely tuberculated surface, a pale brown colour, and varies in size from that of a pea to that of a duck's egg. A little bit heated upon platinum foil over a spirit-lamp is entirely volatilized, and gives off an odour like that of prussic acid. When dissolved in hot nitric acid, and the solution evaporated to dryness on a porcelain plate, a crimson stain is left, which becomes purple on the addition of ammonia. It dissolves entirely in hot liquor potassæ.

Oxalate of Lime ($CaO, C^2 O^3$), which is called the mulberry calculus, from its resemblance to that fruit, is very irregular and rugged on the surface, has a chocolate-brown or dark olive colour, and is of a moderate size. When heated on platinum foil, it exhales the odour of burnt feathers, and becomes white, having changed into carbonate of lime. Hydrochloric, or nitric acid, dissolves this calculus, without effervescence.

Phosphate of Lime ($8\ CaO, 3\ PO^5$) has a spheroidal shape, with a smooth surface and laminated arrangement, a pale-brown or stone colour, and is of moderate size. Like other phosphates, it immediately dissolves in dilute nitric, or hydrochloric acid, but is infusible by an ordinary blow-pipe heat.

Triple Phosphate (MgO, NH^4O, HO, PO^5), also called ammoniaco-magnesian phosphate, has the form of a compressed spheroid, is finely crystalline on the surface, generally has a white colour, and is usually of large size. Under the blow-pipe it gives off ammonia, but is not at all easily fused.

Fusible Calculus is a mixture of the two phosphates, has an irregular form, a rough, but not tuberculated surface, is perfectly white, gives a chalky mark, and is sometimes very large. It is perfectly characterized by its easy fusibility under the blow-pipe.

Carbonate of Lime (CaO, CO^2), when it does occur, which is very seldom, has a spherical shape, a smooth surface, is white, and of very small size. Of course, it dissolves in acids with effervescence, but like any other carbonate of lime, when intensely heated, it parts with its carbonic acid, and is then soluble without effervescence.

Urate of Ammonia ($NH^4O, C^{10} H^4 N^4 O^6$) is very rare, and is rounded in form, finely tuberculated on the surface, *caffè au lait*, or slate colour, and generally smaller than a marble. It dissolves in boiling water; and if liquor potassæ be added, an ammonical odour is given off.

Cystic Oxide ($C^6 NH^6 O^4 S^2$) is very rare, and occurs chiefly in children. It is remarkable from containing 26 per cent. of sulphur. It has an oval shape, a crystalline or smoothly tuberculated surface, a tawny yellow colour, and is of a moderate size. Before the blow-pipe it yields an odour like that of bi-sulphuret of carbon, and is entirely dissipated. It has a waxy consistence, dissolves in liquor ammoniæ, and the solution deposits hexagonal plates. This last characteristic is of itself quite sufficient to distinguish it.

Xanthic or Uric Oxide ($C^{10} H^4 N^4 O^4$) is also rare: it has an ovoid shape, a smooth resinous lustre when rubbed, a brownish red colour, and is of moderate size. It is combustible, and burns with a peculiar fœtid odour. Its solution in nitric acid yields on evaporation a lemon yellow stain.

Under the name of *Alternating Calculus*, various calculi have been described; but as already stated, almost all varieties of calculi are mixed. Uric acid, oxalate of lime, and the phosphates, may all be found existing in the same calculus: for as soon as a nucleus has been formed, perhaps by the descent of a renal calculus, the kind of matter deposited upon this nucleus, will depend entirely upon the state of the patient's system at the time. Often enough phosphates may be deposited at night, and uric acid in the morning.

The urinary sediments commonly met with are called gravel. The red crystalline sediment is always uric acid, and often resembles cayenne pepper. Pink, yellow, or brown sediments are generally urates, perhaps mixed with crystals of uric acid. The white sediments in pale urine are always phosphatic. The oxalate of lime is generally deposited from rather high coloured urine.

These are general statements, and of course will require correction by the use of the microscope, which is the only proper test of the nature of urinary sediments.

In the first place it may be remembered that urates are the only sediments that re-dissolve by heating the urine from which they are deposited, and these under the microscope have an amorphous granular appearance. Secondly that of the sediments which are not re-dissolved by heat, only phosphate of lime and xanthic oxide do not possess a crystalline form.

Under the microscope, the crystals of uric acid are either rectangular plates with two opposite serrated edges, or prismatic and aggregated in clusters, or lozengeshaped, and either aggregated or single: they may also appear as little square plates.

The crystals of triple phosphate occur either in regular prismatic tables, with bevelled edges, or have a feathery appearance, with or without a stellated arrangement. They are generally associated with granules of phosphate of lime.

The crystals of oxalate of lime are either octohedral, or shaped like dumb-bells. Sometimes, however, reniform crystals are found, and serve to explain the mode in which the dumb-bells are formed. The octohedral crystals are very brilliant, and are always seen on the apex, so that they look like distinct little squares, crossed diagonally by two bright streaks at right angles to one another.

Cystine occurs either in six-sided tabular crystals, sometimes with a granular nucleus, sometimes without, or in circular plates with crenated edges.

Hippuric acid may occur in beautiful silky tufts.

Enlargement of the Prostate Gland generally affects the middle lobe to the greatest degree; and as the urethra is thereby lengthened and pushed upwards, a catheter about two inches longer than usual is most convenient for withdrawing the urine when it is necessary to do so. In its chronic state, slow micturition, flattening of the fœces, and a feeling of fulness and weight in the perinæum, are the principal symptoms; but as the sort of patient who becomes affected with enlargement of the prostate generally lives hard, every now and then inflammatory attacks make the case much worse. Then, in addition to considerable heat and pain, especially aggravated at stool, there is generally also retention of urine. Sometimes the canal becomes so completely closed that a catheter will not pass; and as in this case the bladder could not be punctured by the rectum, and as there is great danger of extravasation in puncturing above the pubis, the best plan is either to force the catheter through the substance of the prostate, or to make an incision in the middle line of the perinæum, and introduce a prostatic trochar, if that should be required for drawing off the urine.

The inflammation sometimes results in abscess, which may burst into the urethra, rectum, or bladder, or perhaps may open externally. In whichever of these directions the discharge may occur at first, there is obviously considerable risk of its communicating ultimately with all of them, although such cases are rare. In general, however, the inflammation does not go on to abscess, but

with the aid of perfect quiet, freedom f
ation, warm fomentations, and an anti
regimen, the case may get on well. Th
tioner's judgment must of course be ex
dealing with the abscess if it should for
is only by careful manipulation that th
position for puncture can be ascertained.

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FINIS.

PRINTED AT THE UNIVERSITY PRESS,
32 THISTLE STREET, EDINBURGH.